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TEST GEAR • RADIO • ELECTRO MUSIC • COMPUTERS

No. 94

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ELECTRONICS

The Maplin Magazine

Britain's Best Selling Electronics Magazine

OCTOBER 1995 • £2.25

Printed in the United Kingdom

Build these superb PC Teletext Decoder projects: display & printout Teletext pages via your PC!

UHF Prescaler – extends the range of DFM's by up to a factor of TEN!

Enhance your radio's reception quality with the SSB Filter

Find out about new PC Memory Cards!

MIDI Test Box – our latest music making electronics testing and troubleshooting project

LIVE '95 THE CONSUMER ELECTRONICS SHOW

ENTER OUR GREAT COMPETITION See inside for details!

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OCTOBER 1995
VOL 14. No. 94

IN THIS ISSUE...

PROJECTS FOR YOU TO BUILD!

MIDI TEST BOX 6
This neat and compact microcontroller-based item of test gear facilitates the rapid testing and troubleshooting of modern electronic musical instruments that incorporate MIDI (Musical Instrument Digital Interface) standard connection links. An essential tool for bands, musicians and musical instrument traders alike!

PC TELETEXT DECODER INTERFACE CARD 24
This superb project, when used in conjunction with a suitable TV tuner module such as the one described in this issue, will enable your personal computer (PC) to rapidly select, display and store pages of Teletext in full colour, and even allow you to be able to print out any pages that you wish to retain. Additionally, it equips your PC with a highly accurate real time clock – a standard feature of Teletext.

PC TELETEXT DECODER TUNER MODULE 40
This sister project to the PC Teletext Decoder Interface Card is designed to perfectly complement this system, to optimise the reception of Teletext signals. However, since it picks up the entire TV colour video signal, the project is a useful and convenient building block for TV experimenters, or for enabling a composite video monitor to display TV pictures.

UHF PRESCALER 56
An extremely useful circuit that extends the measuring range of Digital Frequency Meters (DFMs) by up to a factor of ten, so that an older or lesser-spec instrument will be able to match more modern or higher-spec units on operational performance. This circuit uses a combination of surface-mount and conventional components, so it is entertaining to build too!

SSB FILTER 73
This project, aimed at amateur radio enthusiasts, is used to greatly improve the reception of individual stations from amongst a group of overlapping ones, particularly beneficial during DX-ing (long-distance coverage). Essentially, this circuit is an active 8-pole Chebyshev filter, which operates over a closely defined bandwidth to heighten the resolution of existing short wave radio receivers.

FEATURES ESSENTIAL READING!

CIRCUIT BREAKERS 18
In this article, Stephen Waddington boxes clever and avoids unnecessary shock tactics in bringing to your attention the variety of different types of circuit breakers available today, along with how they operate, and their most appropriate applications in the domestic environment. Act on the recommendations provided, and make your living environment as safe as houses!

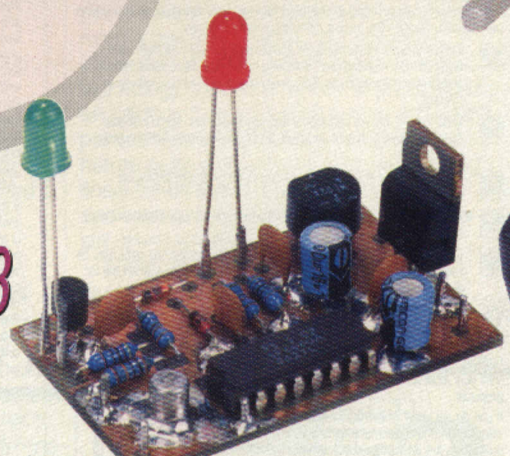
EUROSTAR 32
This will be of particular interest to those about to embark on European travel, our intrepid reporter Alan Simpson writes (champagne glass in hand) from his comfy seat aboard the 180mph Eurostar train about the experience of speeding through the Channel Tunnel (faster than Porsches on the Autobahns) to reach the shores of France in record time. Read the article carefully, and you are in with a chance to win tickets on this dream ride!

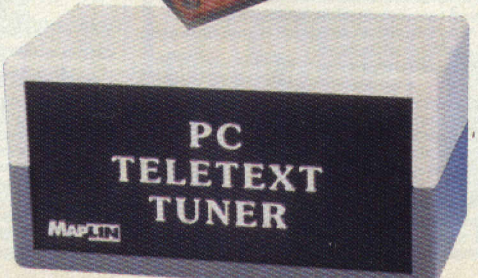
NOISE 35
The fourth and final part of John Woodgate's absorbing series details the complexities of accurately measuring the noise levels of audio and video signals, and gives an explanation of A-weighted, psophometric and chrominance measurements, plus the types of instruments required in taking the measurements, such as the ARM. And you always thought it was your ear that you used for this!

GUIDE TO MODERN DIGITAL ICs 49
Part two of Ray Marston's instructive series explains the differences between the various sub-families of TTL and CMOS logic ICs, looking at the coding system and prefixes used by their manufacturers, which series is best for a particular application, and how this choice depends on widely variable parameters such as logic levels, noise immunity, propagation delays and fan-in/fan-out.

PCMCIA 63
This article by Martin Pipe has been neatly slotted in to inform you of the convenient alternative to conventional hard-wired or disk-type computer memory, that is offered by using Personal Computer Memory Cards, a technology now finding its way into many applications where a durable, easily alterable, and rapid memory access is required.

THE ART OF ELECTRONIC MUSIC 68
The third part of this mellifluous series by Richard Wentk investigates the progress made in the development of sampling technology in synthesizers, the memory considerations required for sampling, how the simulation of various instruments is achieved, linear and exponential sampling, and sound collage techniques used in modern popular music.





REGULARS NOT TO BE MISSED!

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ABOUT THIS ISSUE . . .

Hello and welcome to this month's issue of *Electronics!* There are five projects to build this month, all with different degrees of complexity and uses. For the radio amateur, novice or short wave listener there is the SSB Filter, and like the CW Filter you will not find such good value for a similar kit elsewhere. For those involved with MIDI, there's the MIDI Test Box, and for PC users there are the Teletext Decoder projects. The UHF Prescaler project is a must for those with an older type of Digital Frequency Meter to extend the frequency range. Our various series continue apace, and the news from Universities and Colleges indicates that they are widely appreciated.

New Full Colour 1996 Maplin Catalogue

As you are reading these pages of *Electronics*, the new Maplin Catalogue will be available at the beginning of September at high street news retailers or direct from Maplin. The catalogue is now bigger than ever, with over 1,100 pages of products, many of which are completely new to the Maplin range. And even more fantastic, the price has been reduced, great value for money! So don't miss out! If you cannot get to your local Maplin store or retailer for your copy, then order the new catalogue direct from Maplin, see details on page 62.

Competitions

This month sees another of our major magazine competitions, see page 34. The Eurostar competition which takes in Eurostar and Eurotunnel, has prizes for first, second and runners-up, and is all set to go.

The twelve lucky winners (plus partners) of the LIVE '95 competition have their tickets and are ready to visit the show. Next month we will have another fantastic competition. So don't miss out, order your copy of *Electronics* now!

Internet

Just to mention that you can send messages to us on Internet using the following: **ayv@maplin.demon.co.uk**, **tech_wat@maplin.demon.co.uk** and **site_sur@maplin.demon.co.uk.** After receiving some faxes we found that we had a glitch in the system which failed to forward the messages, but hopefully this has now been sorted out.

Projects

The Teletext Decoder projects have been included this month, but this has meant that RS232, Circuit Breakers, Magnetic Disks & New Applications and Alternative Space Propulsion features have been put back an issue, this will mean another bumper issue next month.

So until next month, from the rest of the team and myself, enjoy this issue.

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Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

1 Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering iron, side cutters, pliers, wire strippers and screwdriver). Test gear not required and no setting-up needed.

2 Easy to build, but not suitable for absolute beginners. Some test gear (e.g., multimeter) may be required, and may also need setting-up or testing.

3 Average. Some skill in construction or more extensive setting-up required.

4 Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

5 Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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Kits, components and products stocked by Maplin can be easily obtained in a number of ways:

Visit your local Maplin store, where you will find a wide range of electronic products.

If you do not know where your nearest store is, Tel: (01702) 552911. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance.

Write your order on the form printed in this issue and send it to Maplin Electronics. P.O. Box 3, Rayleigh, Essex, SS6 8LR. Payment can be made using Cheque, Postal Order, or Credit Card.

Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554161.

If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number Tel: (01702) 552911 and we will happily issue you with one. Payment can be made by credit card.

If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system. If you do not have a customer number or a PIN number Tel: (01702) 552911 and we will happily issue you with one.

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Full details of how to subscribe may be found on the Subscription Coupon in this issue. UK Subscription Rate: £23.76/12 months, £11.88/6 months.

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Prices of products and services available from Maplin, shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%) and are valid between 1st September 1995 and 29th February 1996 errors and omissions excluded. Prices shown do not include mail order postage and handling charges, which are levied at the current rates indicated on the Order Coupon in this issue.

Technical Enquiries

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics*, the Customer Technical Services Department may be able to help. You can obtain help in several ways; over the phone, Tel: (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; by sending a facsimile, Fax: (01702) 553935; or by writing to: Customer Technical Services, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Don't forget to include a stamped self-addressed envelope if you want a written reply! Customer Technical Services are unable to answer enquiries relating to third-party products or components which are not stocked by Maplin.

'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service, return the complete kit to: Returns Department, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Enclose a cheque or Postal Order based on the price of the kit as shown in the table below (minimum £17). If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost plus parts.

Kit Retail Price	Standard Servicing Cost
up to £24.99	£17.00
£25.00 to £39.99	£24.00
£40.00 to £59.99	£30.00
£60.00 to £79.99	£40.00
£80.00 to £99.99	£50.00
£100.00 to £149.99	£60.00
Over £150.00	£60.00 minimum

Readers Letters

We very much regret that the editorial team are unable to answer technical queries of any kind, however, we are very pleased to receive your comments about *Electronics* and suggestions for projects, features, series, etc. Due to the sheer volume of letters received, we are unfortunately unable to reply to every letter, however, every letter is read – your time and opinion is greatly appreciated. Letters of particular interest and significance may be published at the Editors discretion. Any correspondence not intended for publication must be clearly marked as such.

Write to: The Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex, SS6 8LR, or send an e-mail to AYV@maplin.demon.co.uk

TECHNOLOGY WATCH!

with Keith Brindley

When Commodore closed its doors a while back, everyone thought that the end of the Amiga was a dead cert. The friendly-enough little computer ceased production nearly two years ago, and its many users were saddened. It had many features some of the other computer manufacturers only dreamed of long before they actually bit the bullet and added them due to customer demand.

Amiga manufacturing rights passed to Commodore's new owners, Germany-based Escom, and it looked very much as though the Amiga would never be seen again. However, plans are afoot to remanufacture the little box of tricks, and Escom hopes to have sold 22,000 Amiga 4000, and over 100,000 Amiga 1200 machines by the end of the Christmas-time rush. Escom obviously hopes the significant user-base of Amiga owners will maintain the machine with a guaranteed future.

Escom is currently evaluating microprocessors, and expects to be able to move to reduced instruction set computers (RISC) with later models, based on either PowerPC or Hewlett-Packard's PA-RISC devices. The original Amiga devices (Motorola 68000-series) microprocessors aren't expected to be fast enough or powerful enough to cope with processing demands of future multimedia machines. In the interim, however, Amiga 1200 machines will be upgraded from the 68020 microprocessor, while the Amiga 4000 will feature the 68060 device. Existing Escom desktop ranges of PC will continue to be manufactured with Intel devices inside.

General Plumber vs Commander Hedgehog?

It is not yet clear which of the two warring CD-sized digital video disk formats will become the norm underneath the television sets of the future, but they both continue to sign up new troops ready for the coming battles. Sega for instance, has recently volunteered for active duty with Toshiba's two-sided format, in a move which could be seen as vital to any successful format's strategy. Games have to be an integral part of any modern technology, and a video disk featuring products like Sega's will have a decided advantage. In fact, any modern product which doesn't feature games (and by this, I mean the games which are in current fashion) might as well surrender before the battle commences.

IBM Bites the Apple

It was widely expected, but it's still no doubt a jolt to Mac users world-wide, that IBM has announced plans to offer Apple's MacOS as a potential operating system on its brand-new range of PowerPC-based desktop computers.

Until just a year or so ago, this whole situation seemed impossible. IBM and Apple were constantly at loggerheads, and neither manufacturer seemed to even acknowledge the other's existence in the marketplace. Now, with development of the PowerPC microprocessor, the common hardware reference platform (CHRP) due next year, and Apple's next generation of its MacOS system software, it won't be long before Mac-based computers are available from IBM.

Apple itself must only welcome this new departure for IBM. Since licensing its operating system, the MacOS, several computer manufacturers have started to manufacture Macintosh clones, but this is effectively the first range of computers on which the MacOS can run alongside others, such as IBM's own OS/2 Warp, and Microsoft's Windows NT.

A Colourful Future

Colour printers at a reasonable price have been around for a while now. If you didn't mind a speckled output, the first were dot-matrix devices. Next has come ink-jet technology machines, which, while producing an infinitely better looking output, still aren't perfect. The jet technology is by its very nature quite slow, and unless you're using finely-tuned paper (read *very expensive*) and have an up-to-date beast, the results still aren't what you'd ideally want.

There are other systems around (laser, thermal transfer, solid ink and dye sublimation) but these are as yet, still too expensive for most users' likings, although the cost is continually dropping. Tektronix' new Phaser 340 for example, costs around £3,200 or so, which isn't a lot if you say it fast. When you think that monochrome laser printers cost that (and more, if you consider prices in real terms) when they were first introduced, then it's obvious that printers like this will fuel popularity, which in turn will reduce prices further.

Privatised Privacy

The Government has announced plans to consider privatisation of the Office of the Data Protection Registrar (DPR) – the organisation which currently monitors the use of computers to hold data about private individuals. By commencing a study to look at the DPR and its work, the Home Office wants to see if the DPR is still necessary, and if so, if it's viable as a Government-funded organisation, or if not, whether it could be privatised in whole or in part.

Currently, the DPR plays a seemingly vital role in providing a safety net below which privacy standards aren't allowed to fall. It doesn't yet have a brief to monitor the growth of the Internet and the standards of data privacy on it, but surely, it should. Equally surely, that (along with its current function) cannot be done by a third-party, profit-making, privatised business.

This Home Office announcement comes just a few weeks after Greenpeace headquarters were raided by Ministry of Defence Police, who seized computer files containing among other things, data regarding the organisation's members. While all disks taken in such a raid must be returned, and I suppose, *will* be returned when the Ministry of Defence has completed its investigation, it does make an outside observer wonder whether the seized data will remain as private as it should be. Rightly, the DPR should have the powers to monitor the data seized. The question remains, though, would a privatised DPR be *able* to monitor it?

The opinions expressed by the author are not necessarily those of the publisher or the editor.

KIT AVAILABLE (90050) Price £39.99 A1

Many modern electronic musical instruments (early 80s onwards) use the tried and (usually) trusted MIDI (Musical Instrument Digital Interface) format, as an established hardware and software specification convention, to allow the exchange of information between various instruments and accessories, regardless of their make or model. However, if anything goes amiss with a section, or sections, of the interfacing circuitry or its interconnecting wiring, all sorts of problems may be created, to the detriment of the resultant overall sound that is produced. If a fault is intermittent (as is often the case), trying to trouble-shoot and repair the problem is likely to be an involved process, which may make the repair of certain instruments and accessories uneconomic. This need not be the case, if you use the convenient MIDI Test Box project presented in this article.

2 PROJECT RATING

MIDI TEST BOX

Design by Dennis Butcher
Text by Dennis Butcher and Maurice Hunt

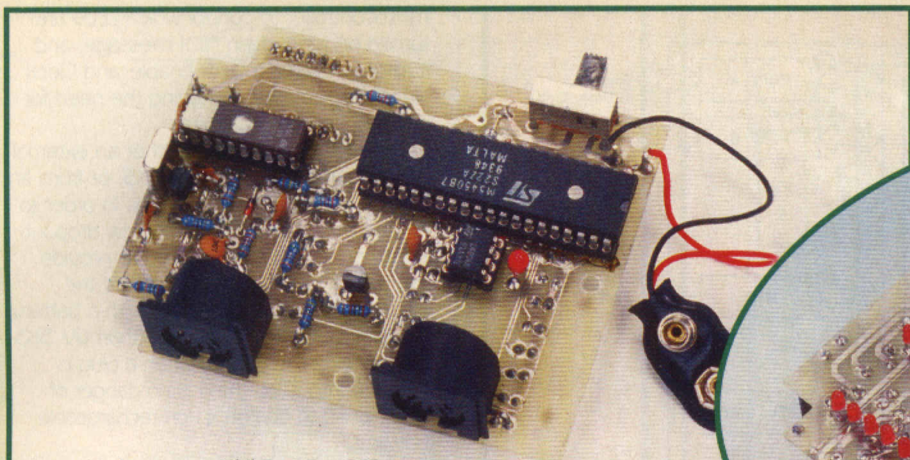
The complete Midi Test Box Unit.

FEATURES

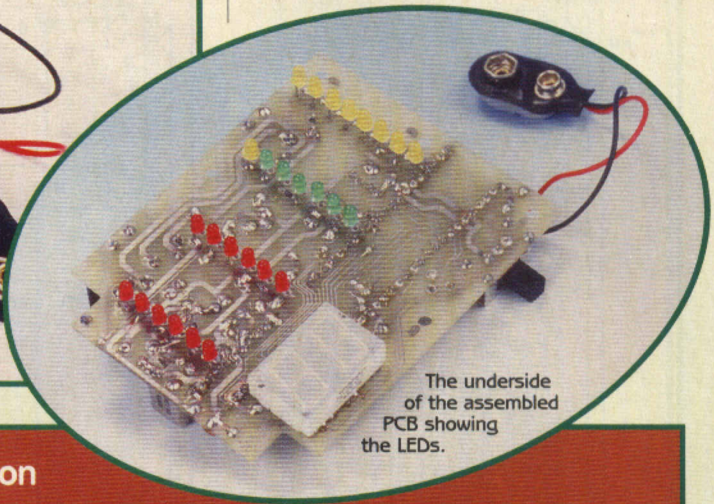
* Hand-held, lightweight and compact
* Battery or mains operation
* Channel identification on LED display
* Error sensing * Helps identify cable faults
* Status indication * Data flow indicator
* Midi thru-connection allows 'live' testing
* Displays 'hidden' codes (e.g., active sensing)
* Helps identify MIDI channel 'mismatches'
* 8-bit ST6 microcontroller based

APPLICATIONS

* Testing of MIDI-based musical instruments, and equipment, new or used
* Setting-up of instruments, PA equipment, etc.
* Ideal for studios, musical instrument owners/ traders, or bands!



Assembled prototype Midi Test Box PCB.



The underside of the assembled PCB showing the LEDs.

THIS project has been designed to facilitate the quick and easy testing of musical instruments and accessories, such as keyboards, drum machines, sequencers, electric guitars, and associated equipment that incorporates the MIDI interfacing format. It uses ST6 microcontroller-based circuitry to decode and display selected MIDI information, in the form of colour-coded LEDs and a 2-digit LED display to show the channel being used. All this is incorporated into a small and lightweight, easy-to-build battery or mains-powered instrument, that will be a boon to anyone who owns or regularly deals with the setting-up of modern electronic musical instruments or synthesizers.

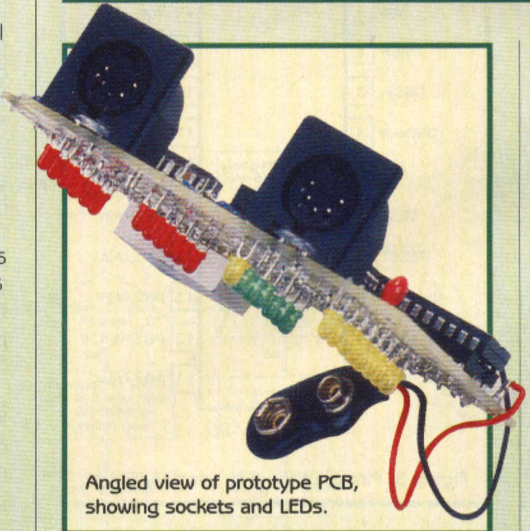
Specification

Supply voltage:	6 to 14V DC (9V DC nominal) internal PP3 battery or external mains adaptor
Supply current:	9mA (with 1 LED on; add approximately 2mA for each additional LED on. Worst case is Channel 16 displayed plus one Status led, ≥ 22mA) (During testing with link LK1 made, current will be >220mA peak)
Size:	145 3 80 3 34mm
Weight (including battery):	225g

Description of MIDI

(including hardware MIDI interface standard)

MIDI data is transferred via a 5mA current loop at 31·25 (±1%) k-baud, asynchronous, with one start bit, 8 data bits and a stop bit. This makes a total of 10 bits with a period of 320μs per byte. The start bit is a logical 0 (current on), the stop bit is a logical 1 (current off), and the least significant bit (LSB) is sent first. For further details on the MIDI standard, please refer to *Electronics*, Issue 22 Volume 6, MIDI Interfacing Techniques. Maplin also stock other MIDI projects and a variety of books covering the subject, see the Maplin Catalogue for details.



Angled view of prototype PCB, showing sockets and LEDs.

Circuit Description

Refer to Figure 1, showing the block diagram, Figures 2 and 3, of the ST6 microcontroller internal block diagram and pinout, respectively, and Figure 4 of the circuit diagram, which will help in your understanding of the following descriptions of how this project operates. SK1 and SK2 are the MIDI in/through sockets; Effectively, sockets SK1 and SK2 are bidirectional (i.e. either one can be used as MIDI input or throughput, and the test box has no discernable effect on the MIDI signal; if it is switched off or the battery goes flat, MIDI data will still flow without interruption. R1, R2 and TR1 detect the signal present on the MIDI loop. The first decimal point on display DY1 is connected to the emitter of TR1 via a current limiting resistor, R5 and this means that the decimal point will flash whenever data is being received; to give an 'activity indicator'. The data is also presented as a nominal 5V square wave to pin 19 (PA0) of IC1, an ST6 8-bit microcontroller; this pin is configured as an input with a leading-edge interrupt and an internal pull-up.

ST6 Microcontroller Pinout Functions

XT1 is the 8MHz crystal for the ST6's internal oscillator. Pin 2 (Timer) and pin 5 (Non Maskable Interrupt) are tied to V_{DD} via 100kΩ pull-up resistors. R8 and C6 keep pin 7 ($\overline{RESET}$) low for long enough to ensure a stable start-up for the ST6 when power is first applied. Pin 16 (PA3) is configured as an input with an internal pull-up, and is used to detect when the LED test routine is enabled by link LK1. Pin 18 (PA1) is configured as an output to drive LED LD11; similarly, pin 17 (PA2) drives LD5, but because of the typically short duration of this signal, a pulse stretcher has been added – D2 prevents C7 from dumping current back into the pin (preventing the

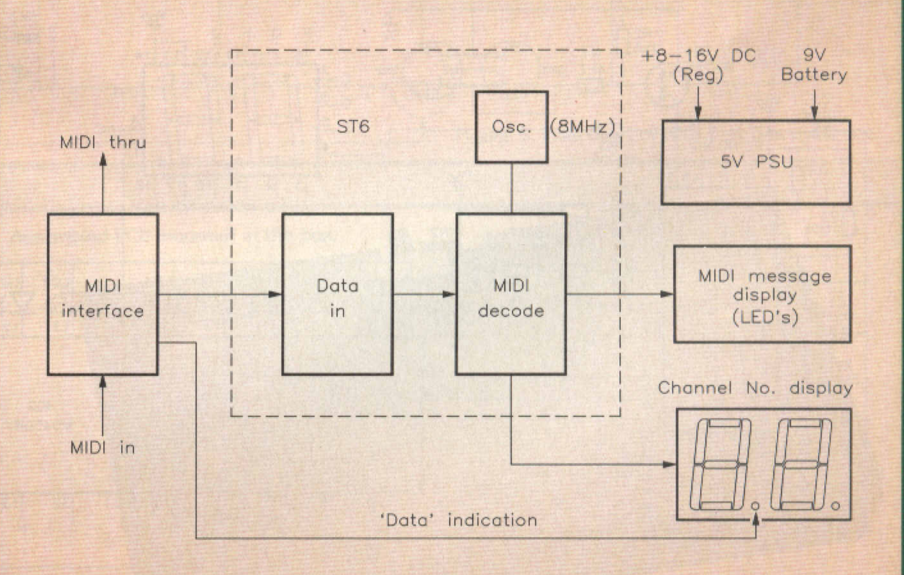


Figure 1. MIDI Test Box block diagram.

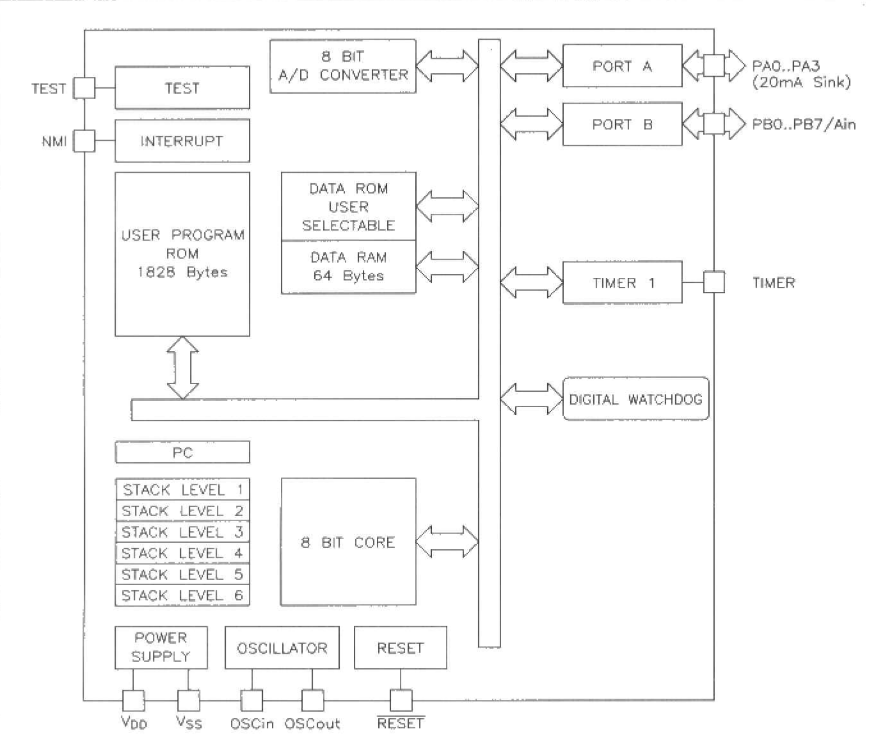


Figure 2. Internal block diagram of the ST6010/20 microcontroller.

possibility of damage to the device as a result), whilst R9 and R10 respectively charge and discharge C7 through TR2, which supplies the necessary drive current to LD5. Pins 12, 13 and 14 (PB3, PB2 and PB1) are configured as outputs with internal pull-ups and provide the Clock, Serial Data and Data Enable signals to IC2.

Display Driver

IC2 is an M5450 LED display driver, chosen because of the requirement to display 36 LEDs and 2-digit LED display segments – using the 34 outputs of the M5450 and two of the ST6 I/O pins configured as outputs, significantly reduced the component count and consequently the size and cost of the final project. The LED brightness is controlled by R7 and all the LEDs are connected in common anode mode.

Serial data is transmitted by the

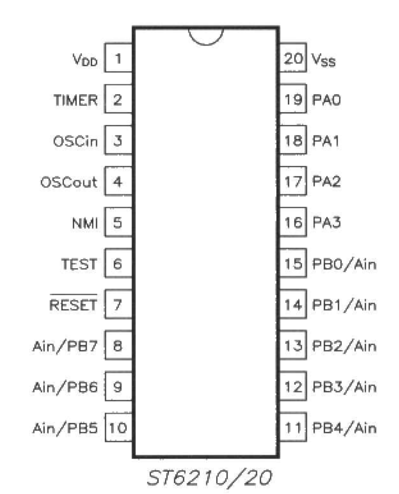


Figure 3. Pinout of the ST6 microcontroller.

microcontroller to control which LEDs are turned on for a given MIDI message, and it also generates a Data Enable and Clock signal via software, removing the need for any other external circuitry.

Power is provided from either an external 9V DC regulated supply via SK3, or from an internal alkaline 9V PP3 battery. In order to extend the battery life, a very low dropout regulator (IC3) has been used to provide the +5V V_{DD} required, and in fact, the circuit will still operate reliably with a battery terminal voltage of a little less than 6V. SK3 disconnects the battery when a plug is inserted into it, so there is no danger of attempting to charge a non-rechargeable battery!

ST6 Program and Flow Chart Explanation

The flow chart shown in Figure 5 is a simplified version of the program flow in the ST6 microcontroller. In very simple terms, the ST6 'looks' for a high at PA3 when it is first powered up. If it detects PA3 to be low, it diverts to the LED test routine for several seconds and then resumes.

The LED power-on test illuminates all LEDs briefly for a confidence check, and then the ST6 waits for a valid data byte to come along – if the first byte is a Status byte, the routine loads between 0 and 2 Data bytes, depending on the message type. The Status byte and Data bytes are processed, and the program branches to determine and display the message (and also the Channel Number for a Channel Message).

Error traps (not shown on the flow chart) detect and display an 'E' on the Channel Number display, and both Local Control On and Local Control Off LEDs illuminate if a Local Control Error occurs (i.e., a valid Control Change Message was detected in the Status Byte, but an invalid Local Control Message Number was contained in the Data Byte(s)).

It is worth noting a couple of points here; firstly, System Messages do not have a channel number, so they only display a message *type*. Secondly, it is not always possible for the Midi Test Box to correctly

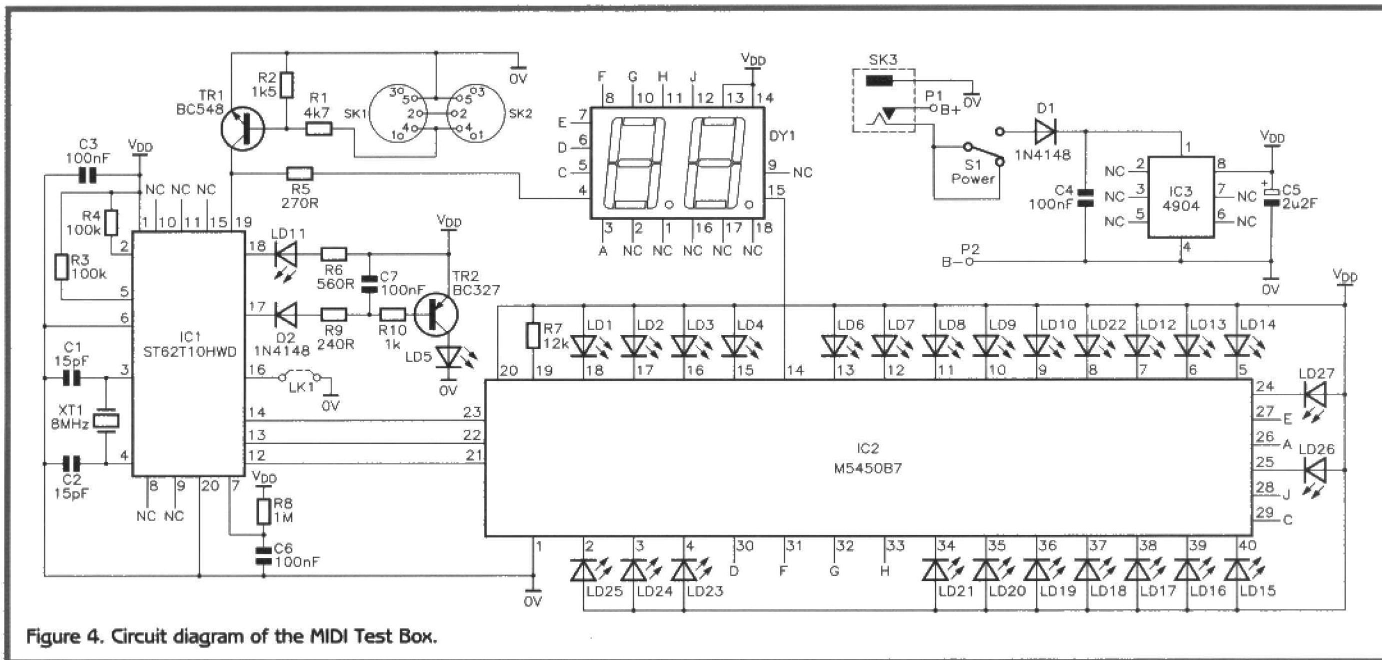


Figure 4. Circuit diagram of the MIDI Test Box.

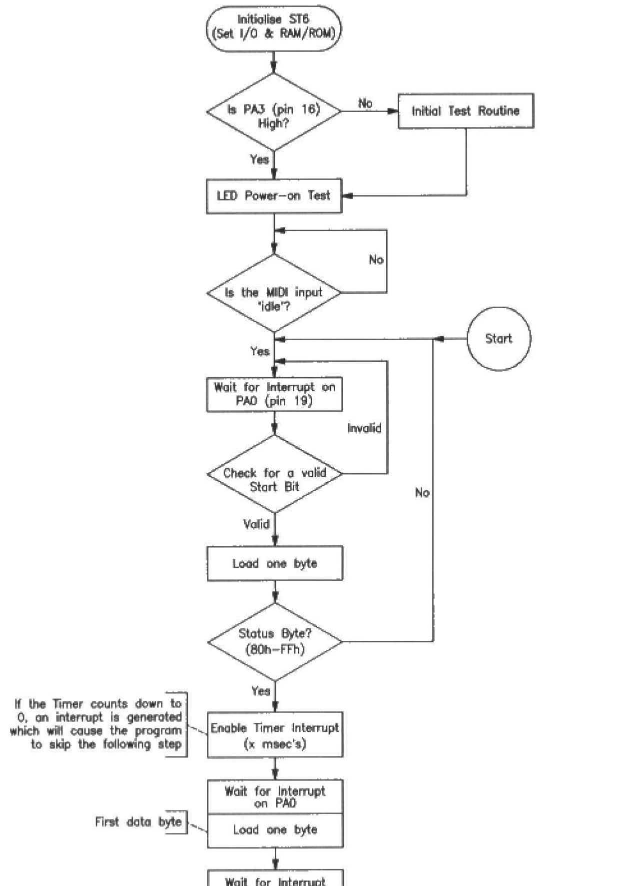
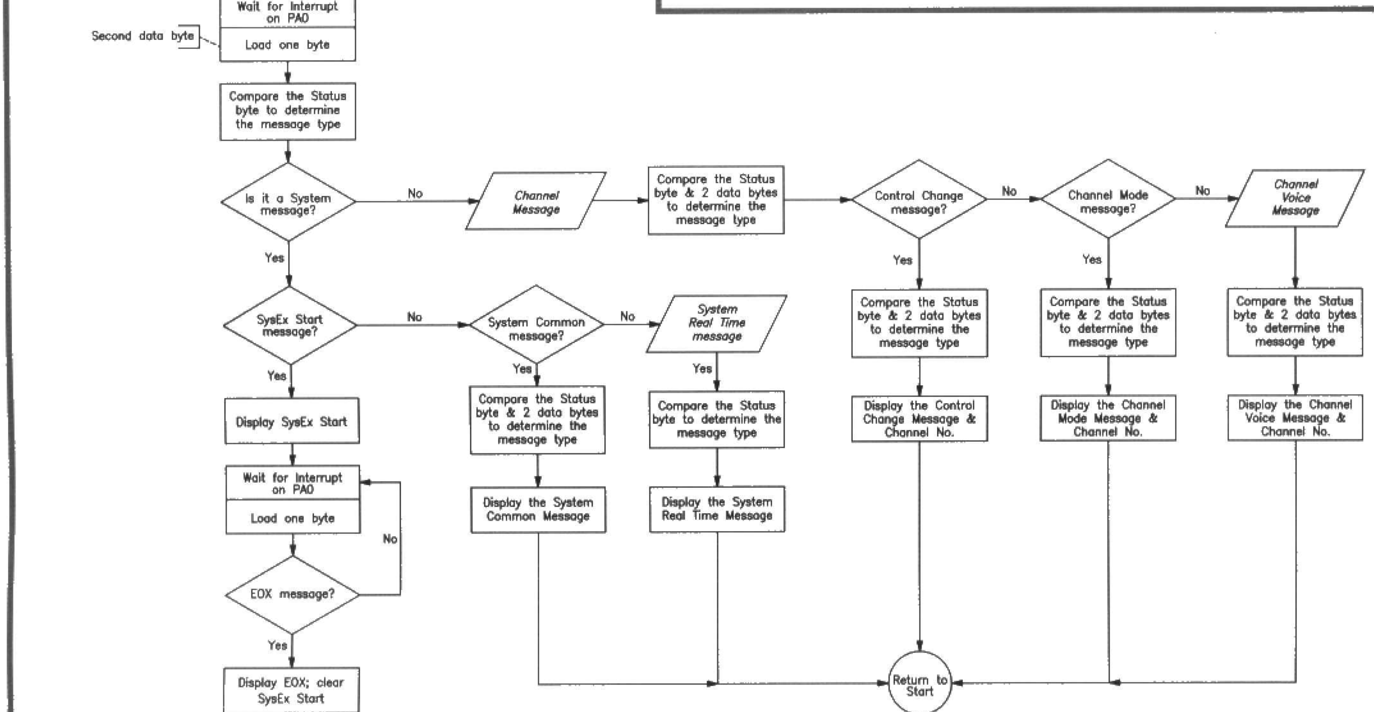



Figure 5. Flow chart of MIDI Test Box operation.

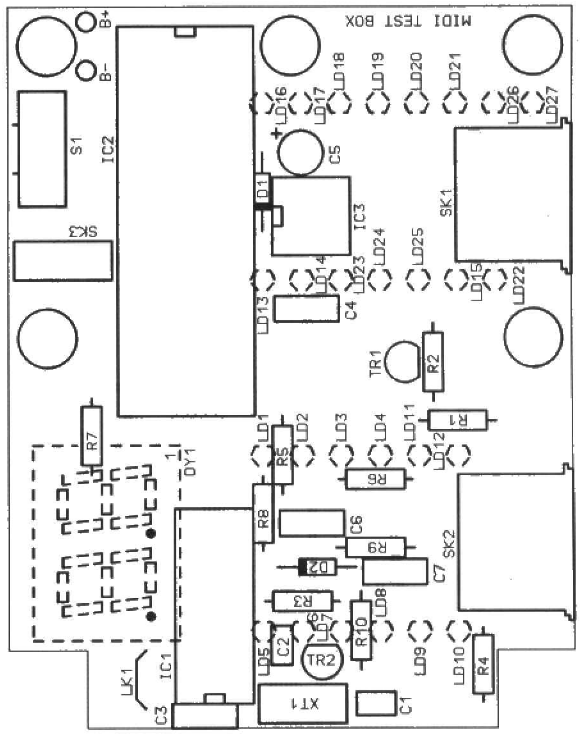


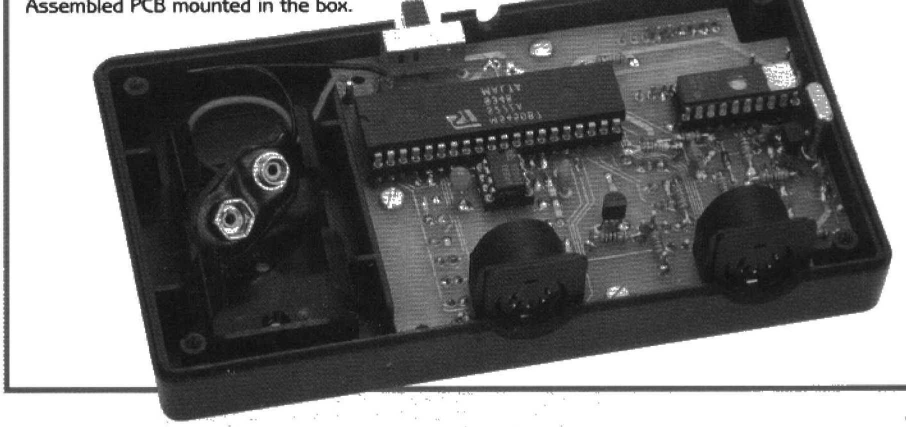
Figure 6. PCB legend and track.

decode messages under certain conditions, and the conditions/effects are listed here:-

1. While 'running status' is active (only on some modern instruments) or while a Timing Clock signal is active, intermittent display of other messages (e.g., Note On) will occur.

2. When a System Exclusive Start is followed immediately by End Of Exclusive, with no gap, the processor gets stuck in a loop because it cannot get back to the start quickly enough to catch the EOX! (Actually, this has only ever occurred with one keyboard when testing during the last 18 months, and that was a very basic old model which was obsolete five years ago!

Assembled PCB mounted in the box.



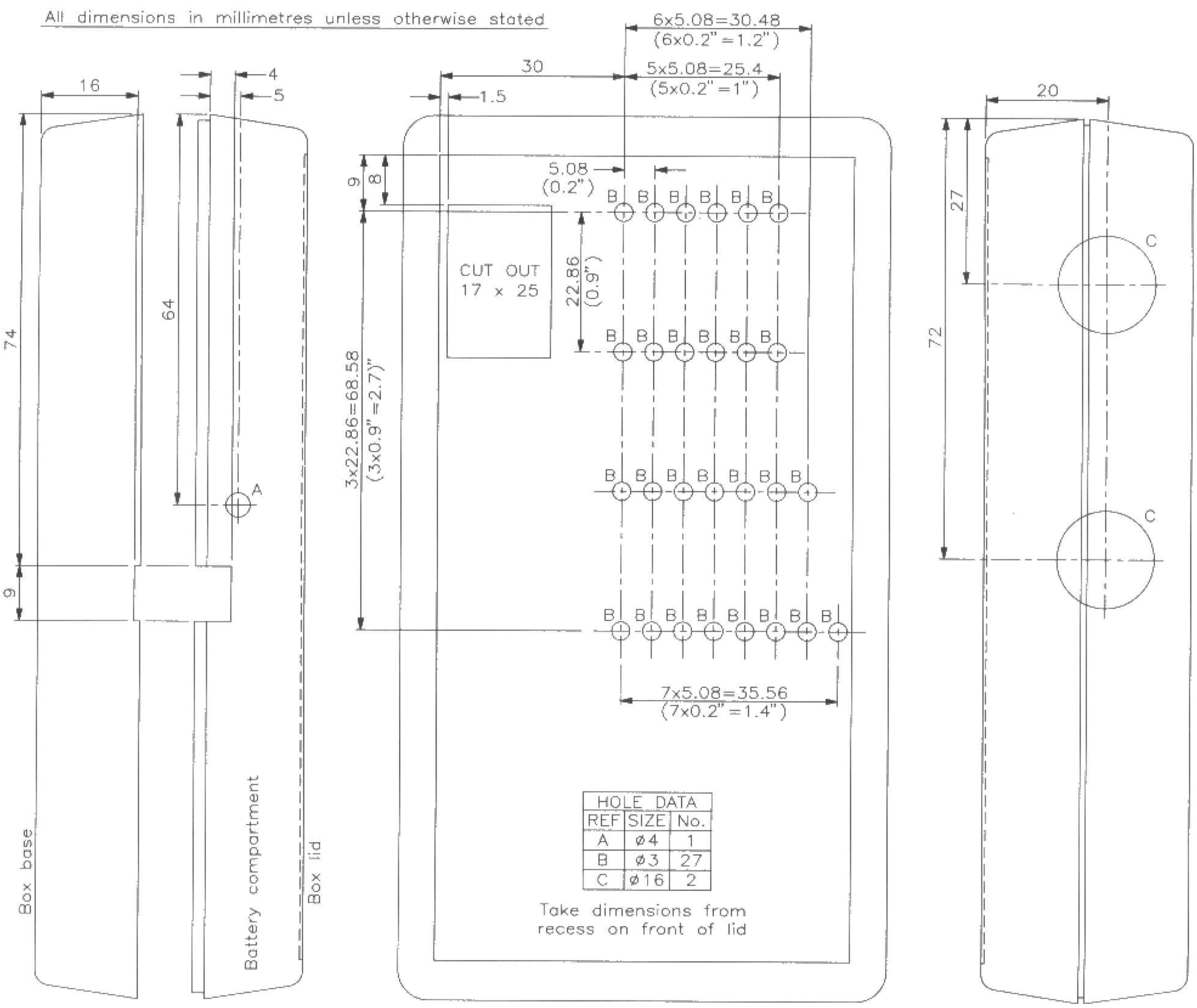
This circumstance should not normally occur, because there is usually at least one Data Byte after a SysEx Start message and before the EOX, otherwise there is not much point in sending it!)

3. Some MIDI commands are sent out on all channels either simultaneously or sequentially, depending on the manufacturer. This may result in an apparently erroneous Channel Number being displayed, because the Test Box only displays the last Channel Number received. (Dim the lights and watch the Channel Number display closely if this is happening; you will see all of the display segments flashing on briefly before the number settles!)

In use, these are very minor limitations; the Midi Test Box is designed to be used more as a piece of test equipment for diagnostics, rather than as a continuous status display. Although it would be possible to use different (and very expensive) technology and have a true 'real time' display of MIDI data, it would be of little practical use, because MIDI data is transient and changes occur so fast that the data would have to be recorded and analysed later – an ideal task for a computer!

The last message received is held on the display until either the unit is turned off or another message comes along. Certain other commercial units display all of the messages received in a time slot (typically 0·5s) and then clear the display; not very helpful if you are at one side of a stage and the test box is at the other! Another common way of displaying the channel numbers is by having 16 LEDs (one for each channel) but using a 7-segment LED display, as in this project, requires less hardware and is easier to read.

Figure 7. Box preparation details.



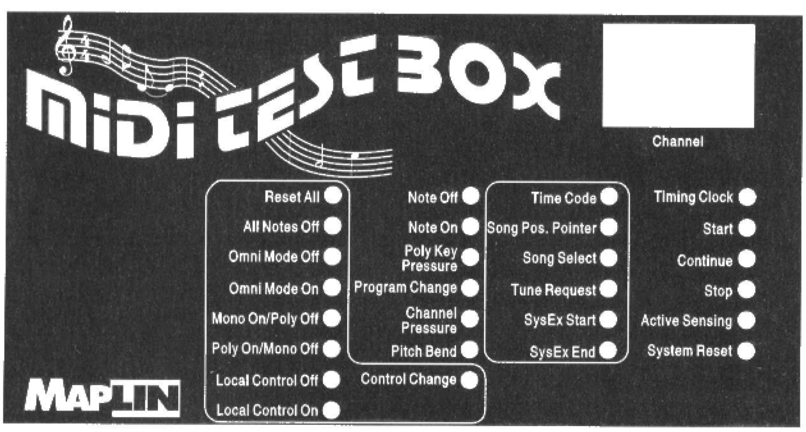


Figure 8. Front panel label (scale 80%).

Construction

This project uses a double-sided PCB, the legend and track of which are given in Figure 6. Note that the LEDs and display mount on the 'track' side of the board. The recommended construction sequence is a slight departure from the usual; this makes it relatively easy to align the LEDs correctly. Please read through the construction sequence fully before starting to build this project, since although it is quite easy to construct, a mistake is not easy to rectify when it is fully assembled!

Fit and solder all resistors, capacitors, diodes, transistors, SW1, SK1 and the two

Message	LED Number
System Common	**Red LEDs**
Time Code	1
Song Position Pointer	2
Song Select	3
Tune Request	4
System Real Time	**Red LEDs**
Timing Clock	5
Start	6
Continue	7
Stop	8
Active Sensing	9
System Reset	10
System Exclusive	**Red LEDs**
Start	11
End	12
Channel Voice	**Green LEDs**
Note Off	13
Note On	14
Pitch Bend Change	15
Poly Key Pressure/Aftertouch	23
Program Change	24
Channel Pressure/Aftertouch	25
Control Change	**Yellow LEDs**
Reset All Controllers	16
All Notes Off	17
Omni Mode Off	18
Omni Mode On	19
Mono Mode On (Poly Off)	20
Poly Mode On (Mono Off)	21
Control Change	22
Local Control Off	26
Local Control On	27

Table 1. LED functions, descriptions and MIDI codes.

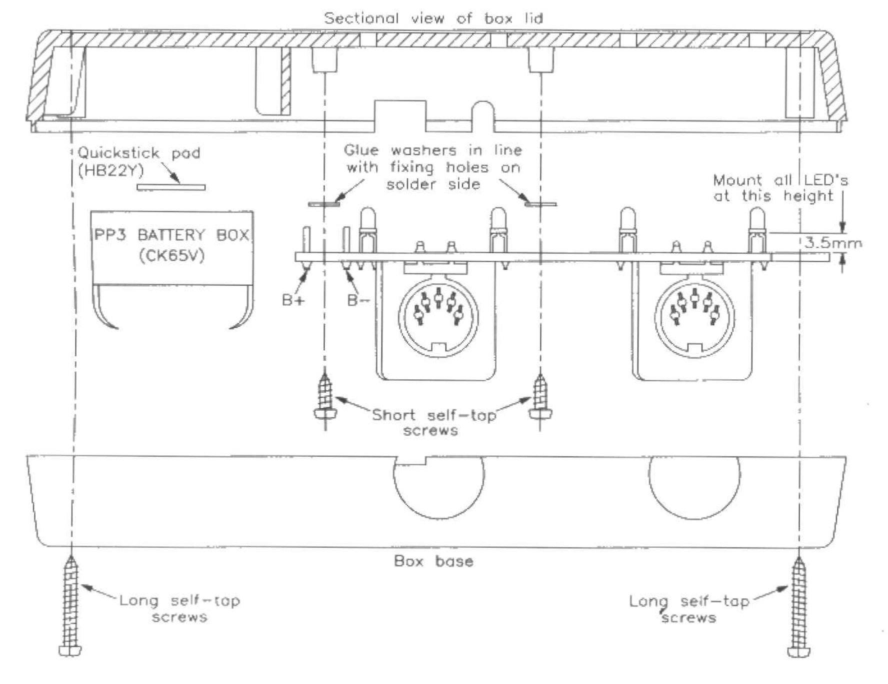


Figure 9. Exploded assembly diagram.

PCB pins, in that order, followed by the display DY1; note that it is mounted flush, on the reverse side of the PCB, with the top of the display in alignment with the top edge of the PCB. Drill and cut the box in accordance with Figure 7. Cut out and use Figure 8, of the front panel label, as a template for the drilling, or use the label itself (having stuck it into position on the front panel), taking care not to deface it during this process.

Referring to the photographs, showing the LED colours and their positions within the front panel area, push each LED into position until it is nearly flush with the PCB. Ensure that each LED is correctly aligned; the short lead denotes the cathode, and should be mounted in the hole indicated with a 'k' on the board. Holding the PCB so that the LEDs don't drop out (!), offer the box lid to the PCB in the correct position; Figure 9 shows the exploded assembly diagram, which will clarify the relative positions of the box contents. Carefully turn the assembly over, and screw the PCB in place using the short self-tapping screws provided with the box. Do not overtighten the screws, as you will need to remove and replace them at least once more before final assembly!

Holding the box with the face firmly pressed down onto a flat surface, carefully push each pair of LED leads so that each LED is pushed to the front of the box. (This should ensure that all LED's are mounted at the same height.) Without disturbing the box, solder each LED in place. (To be doubly certain of their positions, you can just solder one lead of each LED and then turn the box over to check its position against the diagram.)

Unscrew and remove the PCB from the box; trim the LED leads, check their soldered joints and then solder all of the remaining components in position, leaving the quartz crystal until last. On the 'track' side of the PCB, by each of the 5 fixing holes, there is a solder pad; lightly solder a 3mm washer to each pad so that the

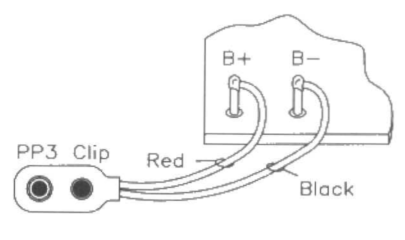


Figure 10. Wiring diagram.

washer will act as a spacer when the board is finally mounted in the box. (This is required because the display and LEDs will protrude slightly from the front of the case after step 6.)

Using a component lead offcut, solder a wire link in place at LK1 position; leave it in a 'loop' proud of the PCB surface so that it may be cut off after testing. See Figure 10, which gives the wiring diagram. Solder the PP3 battery clip to the B+ (red wire) and B– (black wire) terminals. Insert all of the ICs, observing their polarity very carefully and checking that none of the pins are bent during insertion, especially with the 40-pin IC.

Testing and Final Assembly

A test routine to check the function of the LEDs and display is built in to the processor. After a final check of all solder joints, component polarity, etc., connect a PP3 battery and turn on the unit. The LEDs and display should all flash on and off at about 1 second intervals. (Note not all of the display segments are used; it should show '18'.)

If any LEDs do not illuminate, carefully check the solder joints around the LED and display driver IC2, using the circuit diagram as a guide. If nothing is apparently wrong with the connections, then the LED may be reverse connected or defective. If any components need to be changed at this stage, then remember that the PCB has plated-through holes and great care must be taken when desoldering.

When you are satisfied that all is well, cut link LK1 at both ends and remove it. Using the self-adhesive pads, fasten the PP3 battery holder into the battery compartment. Mount the PCB in place using the short self-tapping screws provided with the box. Fit the base of the box using the four longer self-tapping screws provided, feeding the battery connector into the battery compartment. Fit an alkaline PP3 battery (or use a suitable regulated DC power supply) and the Midi Test Box is ready for use! The optional carrying pouch is a worthwhile extra if you intend regular use and/or carriage of the unit, since it provides a degree of protection, and also convenient storage space for leads and a spare battery, etc.

MIDI TEST BOX PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1	4k7	1	(M4K7)
R2	1k5	1	(M1K5)
R3,4	100k	2	(M100K)
R5	270Ω	1	(M270R)
R6	560Ω	1	(M560R)
R7	12k	1	(M12K)
R8	1M	1	(M1M)
R9	240Ω	1	(M240R)
R10	1k	1	(M1K)
CAPACITORS			
C1,2	15pF Metallised Ceramic	2	(WX46A)
C3,4,6,7	100nF 16V Ceramic Disc	4	(YR75S)
C5	2µ2F 35V Tantalum Bead	1	(WW62S)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
TR1	BC548	1	(QB73Q)
TR2	BC327	1	(QB66W)
DY1	Red 7-segment Display 14·2mm (0·56in.) Type C	1	(CZ58N)
LD1-12	Red 3mm Miniature LED	12	(WL32K)
LD13-15,23-25	Green 3mm Miniature LED	6	(WL33L)
LD16-22,26,27	Yellow 3mm Miniature LED	9	(YY38R)
IC1	62T10B6HWD	1	(DC26D)
IC2	M5450B7	1	(UJ53H)
IC3	L4904A	1	(AH86T)
MISCELLANEOUS			
SK1,2	5-pin PCB-mounting DIN Socket	2	(YX91Y)
SK3	1·3mm PCB-mounting DC Power Socket	1	(FK07H)
XT1	8MHz Crystal	1	(UJ06G)
S1	SPDT Sub-miniature Right-Angled Slide Switch	1	(FV01B)
	40-pin DIL Socket	1	(HQ38R)
	20-pin DIL Socket	1	(HQ77J)
	8-pin DIL Socket	2	(BL17T)
	PP3 Battery Clip	1	(HF28F)
	M3 Steel Washer	1 Pkt	(JD76S)
	Quickstick Self-adhesive Pads	1 Pkt	(HB22Y)
	PP3 Battery Box	1	(CK65V)
	Plain Hand-held Box Type HH2	1	(ZB16S)
	Front Panel Label	1	(90052)
	PCB	1	(90051)
	Instruction Leaflet	1	(XV60Q)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	Carrying Pouch Type CB50D	1	(YN72P)
	5-Pin DIN MIDI Connection Lead (1m)	2	(YZ26D)
	5-Pin DIN MIDI Connection Lead (6·5m)	2	(YZ27E)
	Alkaline PP3 Battery	1	(ZB52G)
	Regulated 300mA Power Supply	1	(YB23A)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 90050 (MIDI Test Box) Price £39.99 A1

Please Note: Where 'package' quantities are stated in the Parts (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue

MIDI Test Box PCB **Order As 90051 Price £7.49**

MIDI Test Box Front Panel Label **Order As 90052 Price £2.29**

What's On?

RSGB International Conference

The 1995 RSGB International HF Conference will take place at Beaumont Conference Centre at Old Windsor, Berkshire, from 9th to 10th September. The convention will feature lectures from some of the world's top HF operators and DXers.

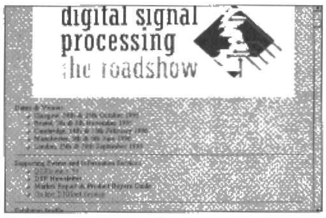
A highlight of the conference for those attending will be the QRRL's DXCC QSL card checking facility. This provides a means of having precious QSL cards checked for the prestigious DXCC award without the necessity of trusting them to the international mail. DXCC application forms and further details of the Convention are available direct from the RSGB.

Contact: RSGB, Tel: (01707) 659015.

Green Engineering

Engineering for sustainable development is the theme of a major international conference, organised by the Royal Academy of Engineering, to be held in London on 21st to 22nd September. The event will focus on the challenges set by public expectations in the areas of manufacturing and transport, and will include presentations on ethical, political and commercial issues from several eminent non-engineering speakers.

Contact: Royal Academy of Engineers, Tel: (0171) 222 2688.



Digital Signal Processing Seminars

The Electronics Division of publisher and event organiser, Miller Freeman, has announced a series of seminars on Digital Signal Processing, which bring together industrial names such as Texas Instruments, Mentor and Silicon Systems.

Targeted at engineers and management involved in mixed signal and digital signal processing design and technology the event will focus on both the practical and theoretical elements of DSP design. Miller Freeman is limiting the number of exhibitors to twenty, each with a focus on the manufacturing or distribution of software-based DSP solutions.

The events which will run from October this year through to September next, will take place across the country from London to Glasgow. To tie in with the events, Miller Freeman has launched an Internet site which outlines participants and events. The Web site can be accessed at: **http://www.diginet.co.uk/**

Contact: Miller Freeman, Tel: (0181) 855 7777.

DIARY DATES

Every possible effort has been made to ensure that the information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

27 August. East Coast Amateur Radio and Computer Rally, Clacton Leisure Centre. Tel: (01473) 272002.

2 September. Wight Wireless Rally, Arreton Manor Wireless Museum, Newport, IOW. Tel: (01983) 567665.

2 to 3 September. HF SSB Field Contest Weekend, Crystal Palace & District Radio Club, London SE19. Tel: (0181) 699 5732.

3 September. 18th Telford Rally, Telford Exhibition Centre, Telford. Tel: (01707) 659015.

5 to 7 September. International Conference on 100 Years of Radio, Savoy Place, London, WC2. Tel: (0171) 240 1871.

10 September. Southend & District Radio Society, 75th Anniversary Radio & Computer Rally, The Cliffs Pavillion, Southend. Tel: (01702) 353676.

10 September. Lincoln Short Radio Hamfest, Lincoln Showground, Lincoln. Tel: (01522) 525760.

10 to 12 September. European Computer Trade Show, Olympia, London. Tel: (0181) 742 2828.

10 to 13 September. PLASA – Light & Sound Trade Show, Earls Court, London. Tel: (0171) 244 6433.

12 September. Opening Night and Dayton '95 by Herb Asmussen and George Beasley, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

12 to 14 September. First IEE/IEEIE International Conference on Generic Algorithms in Engineering Systems – Innovations and Applications, Sheffield. Tel: (0171) 240 1871.

13 to 14 September. European Optical Communications Show, Olympia. Tel: (01425) 473535.

19 September. Tesla and AC power, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.

19 to 24 September. LIVE '95 – The Consumer Electronics Show, Earls Court, London. Opening times: 12 noon to 9.00pm weekdays, 10.00am to 6.00pm weekends. Tel: First Call Ticket Agency (0171) 396 4545.

19 to 21 September. Computers in Manufacturing Exhibition, NEC, Birmingham. Tel: (01932) 564455.

20 to 21 September. Electrical Engineering Show, Hinckley Island Hotel, Hinckley. Tel: (01732) 359990.

26 September. Top Band DF Construction, by Geoff Foster, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

3 to 5 October. Electronics Data Exhibition, NEC, Birmingham. Tel: (0181) 742 2828.

4 to 6 October. Electronic Data Exhibition, ICC, Birmingham. Tel: (0181) 742 2828.

10 October. Inside Your PC by Martin Rhodes, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

12 to 13 October. Electrical Engineering Show, Forte Post House Hotel, Basildon. Tel: (01732) 359990.

20 to 21 October. Leicester Amateur Radio Exhibition, Granby Halls, Leicester. Tel: (01707) 659015.

24 October. QRP by Norman Field, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

25 October. Junk Sale, Lincoln Short Wave Club, Lincoln. Tel: (01427) 788356.

27 to 29 October. Acorn Road Computer Show, Wembley Centre, London. Tel: (01295) 788386.

7 to 9 November. Software Development Exhibition, NEC, Birmingham. Tel: (0181) 742 2828.

8 to 11 November. Apple Expo, Olympia, London. Tel: (0171) 388 2430.

10 to 12 November. Design & Technology Education Exhibition, NEC, Birmingham. Tel: (01425) 272711.

11 November. Bingley Hall, Staffordshire Showground, Stafford. Tel: (01473) 272002.

14 November. Operation Raleigh, by John Leyton, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

21 November. Weather Satellites – An illustrated talk from Mark Clarke, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.

22 November. Construction Contest, Lincoln Short Wave Club, Lincoln. Tel: (01427) 788356.

28 November. Microphones by Jack Cluley, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

28 to 30 November. Computer Graphics Expo, Wembley Centre, London. Tel: (0181) 995 3632.

7 to 11 December. Computer Shopper Show, Wembley Centre, London. Tel: (0181) 742 2828.

12 December. Open House and Night on Air, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

19 December. Christmas Social, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.

25 December. Xmas Greeting on Air 11:00hrs 145-275MHz, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

CORRIGENDA

ISSUE 93/SEPTEMBER 1995.

The Art of Electronic Music, page 13, caption for lower drawing should read: Figure 10. The DX7 envelope generator bears little resemblance to a traditional ADSR. The curve is controlled by setting four rates and four levels. The levels can be any value, so that strange, previously impossible envelope curves can be produced.

A readers' forum for your views and comments. If you would like to contribute, please address your replies to:

The Editor, Electronics – The Maplin Magazine P.O. Box 3, Rayleigh, Essex SS6 8LR, or send an e-mail to: AYV@maplin.demon.co.uk

Dear Editor

AIR YOUR VIEWS

RIAA Correction

Dear Editor,

I am writing about the table purporting to compare the performance of LPs and CDs on page 21 of the April 1995 issue. In this table, figures are quoted for the performance of a CD system (i.e., at peak levels), in comparison with figures for pickup cartridges. It is unrealistic to claim that such figures are comparable, since the last two columns do not represent the performance of the complete analogue disc system. Anyone who has ever tried to measure the frequency response of an LP/cartridge combination knows that doing this to an accuracy of 0·2dB is quite unrealistic, and that achieving ±1dB with respect to the RIAA curve is excellent in the context. Secondly, although it is perhaps possible that a moving magnet cartridge in itself has a signal-to-noise ratio of >82dB, a vinyl pressing would be hard-pressed to exploit it (pun intended).

But, it is in regard to distortion that Mr. Meechan's table is so misleading. An horrendous amount of distortion can be generated in playback, due to the geometry of the groove and the finite size of the stylus. Most of this can be calculated, though it is not easy to measure. A figure of 10% is not unreasonable for what is called pinch effect at high levels at the end of a side. Readers can get some idea of what this sounds like, by playing back a mono LP or pop single, and listening to the vertical information which comes from the groove. This is comprised of even harmonic distortion, and to hear it, it is necessary to listen to the difference channel. One way of doing so, is by connecting a loudspeaker between each of the red terminals of the left and right outputs of a stereo power amplifier (similar to the Hafler surround-sound system – see *Electronics* July 1994, p.50). Listening to this loudspeaker (on its own) will reveal a distorted sound pitched an octave higher than the music on the disc. The same distortion is present on stereo records too. It is underneath the music, but undeniably there, and largely accounts for the unclean sound heard on all organ or choral music on LPs. Wow is not only a function of turntable quality, but also depends on how accurately the hole in the disc has been centred. While LPs have a lot to commend them, the cold hard facts about the specifications of the total system are not impressive, and the writer of the article did not give the full picture.

Dr. David Pickett, Director of Recording Arts, Indiana University School of Music, Bloomington, Indiana, USA.

Thank you for your comments, we will be passing your letter onto the author concerned, and give him a right of reply if necessary. Personally I'm still waiting for the ultimate media, as I can find fault with records, CDs and tapes. Pleased to know that Electronics is being read in the US of A.

Wider Still and Wider

Dear Sir,

With reference to your article 'Collision Earth' in issue 93, the following may be of interest. Firstly, the largest observable meteor/comet crater could be 'Gosses Bluff' in central Australia. It is nearly circular, 30km in diameter, and has walls 200m high. It was formed by a comet crashing into Earth 130 million years ago, at a speed of 70km/s, and on impact, threw up rock from 3,000m depth to the surface. The force is estimated as being 200,000 times greater than that of the Hiroshima 'A' bomb. It was recognised as such recently by the 'shatter cone' effects of the pushed up debris. The above fills in the rather large gap between 65 and 208 million years in Table 4 on page 37. My information is from a video by Gamma Films, produced by Klaus Jaritz and titled 'Australia – The First 4 Billion Years', and is available from the New South Wales Department of Mineral Resources. Please pass on my compliments to Mr Clarkson on an excellent article.

Mr. B. J. Dickson, Lanarkshire, Scotland.

Thank you for sharing this information, which would indeed appear to fill the generous chasm in the dates printed in Table 4, and good to hear that you enjoyed the article in question. I'd be surprised though, if America didn't have a bigger crater than Gosses Bluff – they usually manage to beat everyone else on size!

STAR LETTER

In this issue, Bob Cooper, from Blewbury in Oxfordshire, wins the Star Letter Award of a Maplin £5 Gift Token, for his letter.

★★★★★★★★★★★★★★★★★★★★★

Dear Sir,

Has Maplin ever considered getting involved in the area of home control and communications? This would appear to be an area of enormous potential for the amateur electronics enthusiast. The ability to monitor and control equipment in the home via the telephone is an important element. A project in issue 92 of *Electronics* provides for remote control by telephone without the need for an electrical interface between the telephone and home control equipment. The technique has rather limited potential and does not provide any confirmation that the control action has been undertaken nor provide for status monitoring. Is it possible to develop a project kit that allows DTMF signals to be used via the telephone to select control functions or status reports? I am also seeking to construct an audio/video switching facility for my home. This would allow several audio and video sources to be switched to a number of receivers around the house. The output from my VCR, for example, could be switched to any of several TV sets in the house. The outputs from my CD player, tape cassette and FM tuner could be switched to amplifiers and speakers in any room of the house. Furthermore, expensive equipment such as VCRs, CD decks, etc., could be housed securely in a central location along with all their associated clutter of tapes and discs. This will create a more versatile, tidier and more secure home audio/video system. A BYTE magazine article by Steve Ciarcia in February 1986 described a project for an audio/video switch based on the 74HC22106 8 × 6 crosspoint switch IC. Presumably, technology has moved on over the past decade, and there are more sophisticated ICs available that are within the reach of the amateur enthusiast? I would want to add remote control of the VCR, CD deck, etc., via the existing handsets, so it would be necessary to have a detector in each room that could transmit the handset signals to the central location. Could Maplin provide a suitable project kit to meet this requirement? Is the Neuron chip that is being picked up by a growing number of companies as the basis of advanced home control systems in the US appropriate for the DIY market in the UK? Perhaps an article in *Electronics* on this chip and its uses would help to generate interest in the UK and raise awareness of the potential of home control and communications. There is enough potential in the home control and communications area to stimulate a range of Magazine articles and projects, and link into a number of existing project areas, such as home security, entertainment, heating and lighting control, etc. How about it Maplin?

Thank you for your letter, which raises quite a few points of interest concerning electronics in the home. Firstly, regarding the Call Code Switch in issue 92, although it does not provide any feedback of switching action, the unit incorporates a margin for error in the received number of coded rings, since the number of rings you hear on calling does not always match those heard at the other end. Reputedly, this unit is dependable in operation, and the beauty of it is that the call costs you nothing. However, a DTMF version would be a useful idea, though the call would not be free of charge. Perhaps readers in the know would care to write in and shed more light on the ICs you mention. Maplin will certainly be looking into introducing more kits and products for electronic control within the home.

★★★★★★★★★★★★★★★★★★★★★

Panel Beating

Dear Sir,

I am writing in connection with the feature on Bass Unit Construction by David Purton (August 1995, Issue 92). As the Trade Association representing wood panel products in the UK, we were somewhat alarmed (as indeed was one of your readers who brought the article to our attention) to read the safety warning published in the above mentioned feature. Whilst the first four lines of the warning extol the virtues of MDF (Medium Density Fibreboard), the remainder would be more likely to put people off using it. There is much misinformation given about MDF and its constituents, and in our opinion, this feature has served to propagate this, particularly in relation to the reference to the adhesive binder being carcinogenic and therefore by implication, that MDF must be a carcinogenic material, which is categorically not the case. The important note for your readers using MDF, is to be aware that when cutting it with power tools, quite a lot of fine wood dust can be released. Being comprised of primarily softwood, the Health and Safety Executive consider the dust from MDF to present the same degree of health hazard to that of softwood. It is because of these possible health hazards (which tend to be associated with continuous exposure to wood dust) that people should follow the common sense advice of working in a ventilated space and in circumstances where there is no fixed extraction, people should wear a face mask. Our Organisation has a lot of useful information for users of MDF and other wood based panel products, and we would be only too happy for your readers to contact us for this or for clarification of any of the above points.

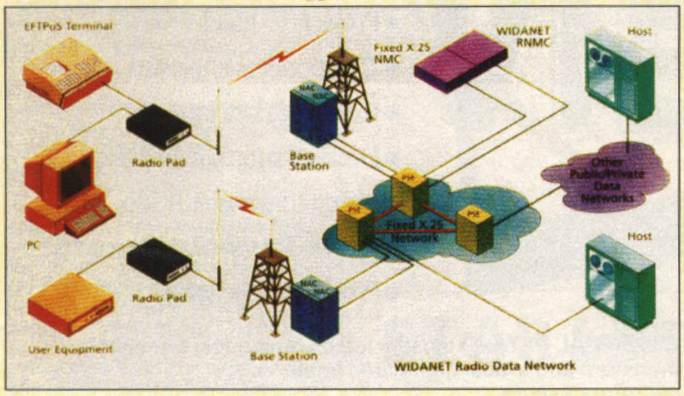
Contact: (0181) 751 6107.

Alastair F. Kerr, Technical Manager, Wood Panel Products Federation, Feltham, Middlesex.

Thank you for your letter. The safety warning was provided by the author of the article, David Purton, who is a regular user of MDF, being as he is, a professional Hi-Fi loudspeaker builder. The actual MDF products themselves usually carry similar safety warnings, and we have a responsibility to keep safety a priority when it comes to our published projects, since if we omitted to include warnings (or played down the suggestion of danger in them), and people were injured as a result, we would receive many more complaints, and quite possibly court cases, than those we receive complaining about the warnings given, of which, yours was the only one we received relating to this article.

NEWS Report

Wireless Data Technology Goes Live in South Africa



A new radio-based data network, which utilises Racal Messenger's WIDANET system, has been launched in South Africa. The network gives businesses in both urban and rural areas, access to a cost-effective, fast and reliable wireless data service, for applications such as credit/debit card authorisation, telemetry, remote security alarm monitoring and vehicle tracking communications. The new service in South Africa follows the introduction of a similar system in Moscow in May, which also uses Racal's WIDANET technology.

WIDANET enables electronic data to be transferred by radio on to Telkom's X.25 SAPONET-P network, via a small subscriber modem known as a Radio-PAD. There are no telephone wires, engaged signals or delays for connection, and the system is inexpensive and completely transportable.

During the pilot project, Telkom established that there was a great demand, especially among the financial institutions. It is envisaged that this service will greatly contribute to decreasing credit and petrol card fraud, which currently amount to millions of pounds a year. The first phase of a countrywide network is to be established in the Gauteng, formerly PWV, Western Cape and Kwazulu/Natal areas.

Contact: Racal, Tel: (01734) 669969.

Marble Sensing Technology

A project, in which the University of Lausanne (EPFL), the Centre Suisse d'Electronique et de Microtechnique (CSEM) in Neuchatel, the commission for the promotion of Scientific Research (KWF) and Logitech all participated, has now come to fruition, giving rise to a new technology called the Marble Sensing Technology.

The principal of Marble Sensing Technology is based on the optical measurement of movement, whereby a camera measures a shift of a picture and evaluates it. The entire evaluation takes place in the sensor, which is essentially the heart of the system.

With the help of Marble Sensing Technology, future input units will be able to function completely optically and therefore, without wear and tear. In future, trackball or computer mouse performance will no longer be impaired by dust or dirt. Users of laptops in particular, who are well acquainted with the drawbacks of built-in trackballs, will value these advantages.

Logitech is currently working to produce its first product series, which will be appearing on the market by late 1995. By the end of summer 1995, the first notebooks using the new Marble Sensing Technology will be available at specialised dealers.

Contact: Logitech, Tel: (01344) 894300.

Apple Provides PCs for Homeless

Apple Computer UK has donated Macintosh computer equipment to the UK's first purpose-built 'Foyer' – a unique residential and training centre set up in South East London, to provide homeless young people with the skills and training to build a new life.

Apple has donated Macintosh desktop computers and LaserWriter printers, aimed at giving residents access to a wide range of information technology opportunities, including designing their own pages on the Internet, publishing their CVs to potential employers on-line, and receiving training on a wide range of software, from word-processors through to spreadsheets, desktop publishing and design packages.

The Camberwell Foyer is the first scheme of its kind in the UK, and occupies a building owned by London and Quadrant Housing Trust and managed by Centrepoint, the charity dedicated to working with homeless young people.

Contact: Apple Computer, Tel: (0181) 730 2480.

Work and Play on the Move

Last month, we reported on the results of a survey from BIS Strategic Decisions, which reported that only 43% of laptop PC users actually use them for mobile working. Perhaps the guys at Portable Add-ons should have read the results of this survey before launching their latest product. The Portable Add-ons CD Mobile is a twin-speed CD-ROM drive, which doubles as a personal CD player when not transferring data to a PC. Neat idea, but will people actually use it for its intended purpose of combining work and play while on the move?

Priced at £299, CD Mobile is based around a superior CD-ROM drive than is found on many desktops. Fully Multimedia PC version 2 compliant, the double speed unit supports Video CD and CD-i, in addition to CD-ROM modes 1 and 2, audio CDs, multi-session Photo CD and CD-XA. The sustained data transfer rate is specified as 300k-byte/s, with an access time of around 360ms.

Contact: Portable Add-ons, Tel: (01483) 306 078.

Bay and Novell Build Test WAN

Bay Networks has signed an agreement to integrate its routers to serve as a key component in the Novell Corporate Test WAN, an enterprise-wide test environment for multiple vendor interoperability and network integration testing. The Novell Corporate Test WAN deploys a range of internetworking products to offer a real-world test WAN environment, which tests product interoperability and integration development. Bay Networks has installed its Backbone Link Node (BLN) routers in the testing environment, supporting a wide variety of industry-standard protocols operating on Ethernet, Token Ring, and FDDI networks, and in the future, ATM.

Contact: Bay Networks, Tel: (01628) 402104.

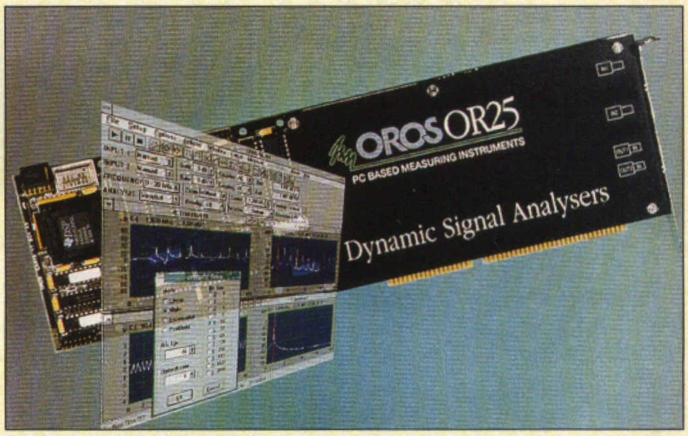
Virtual Instrumentation

How long before we all dump our oscilloscopes and multimeters in favour of the PC? This is more of a reality than a proposition. This month, French company OROS launched a measurement card which slots into the back of the PC, bringing laboratory digital analysis, and oscilloscope functionality to the desktop.

Four models are available in the OR25 range, operating on 2, 4, or 8 input channels offering real time measurement and fast fourier transform analysis for signals in the 0 to 20kHz bandwidth, and for multi-signal analysis, up to 26 channels can be sampled simultaneously.

OR25 simplifies lab, field and production line measurements with a Windows interface, which can be customised with Visual Basic and further linked into post-measurement analysis software using dynamic data links. Here lies a key benefit of a PC-based system of traditional measurement methods – readings can be recorded in real time, at a later date. Near analogue quality processing is achieved using the full 16bits across each channel to record data, combined with a dedicated 32-bit processor to manipulate data into a format suitable for storage by the PC.

Contact: OROS, Tel: (+33) 76 90 63 36.



Indoor Aerial

Are you plagued by poor television reception? The growing band of users of PC TV tuner cards – and millions of viewers of ordinary TV sets – can now buy an indoor TV aerial which gives complete Teletext pages, sharp pictures, and clear sound, and is convenient to use, because it doesn't have to be moved every time the channel is changed.

Called Interial, the device's field of signal pick-up is very different from that of a conventional Yagi type indoor aerial. Indeed, the device has much more in common with rooftop BB-grids – the type of aerials typically used to overcome reflected-signal problems. Interial flat indoor aerials provide good gain and low directionality. Better gain increases the amount of signal delivered to a TV set or video recorder, and improves the overall quality of picture and sound reception.

Low directionality simply means there is no need to point the aerial exactly at a TV transmitter. This, together with close proximity to a wall, greatly reduces two irritating TV reception problems such as ghosting, where double or treble images appear on screen, and Teletext character drop-out, where incomplete Teletext pages are received.

It also means that, unlike ordinary indoor aerials, there is no need to move the aerial when changing channel. Measuring 490(h) × 460(w) × 5(d)mm, Interial is available through high street electrical stores, priced £29.95.

Contact: Rovic Communications, Tel: (01245) 226867.

School of the Future

According to the results of a survey commissioned by Apple Computers, teachers predict that as class sizes grow over the next 10 years, technology will make teaching easier. Computers will increase the learning resources available – via CD-ROM and the Internet, for example – and development of tailored educational software will enable staff to take a more supervisory role. In addition, technology will play an important role in the National Curriculum by 2005. However, this will not mean the end of the textbook – 75% of all the teachers questioned believe textbooks will still have an important role. Most teachers also felt that children with access to a home computer have a learning advantage over those without, and that parents will become increasingly important in helping and supervising their children's education.

Teenagers have a very similar view of future education to their teachers, supporting the claim that every pupil will have a computer by 2005. The great majority of teenagers (85%) envisaged that by 2005, they would be able to take part in classes and other interactive gatherings from home via a television screen. However, only 6% thought that there would be more education at home in 2005. When asked a similar question, the majority of adults (73%) stated that, in ten years time, they would still rather go in person to 'meetings' than attend via a television screen.

Apple's research was commissioned in order to gather views on what life will be like in ten years time, and how technology will impact people's lives. Four different groups of people were interviewed: a demographically representative sample of adults, plus business people, teachers and teenagers.

Contact: Apple Computer, Tel: (0181) 730 2480.

Satellite Market in Decline

New research by GfK Marketing Services Ltd. indicates that the number of British households with satellite dishes did not grow significantly in the first quarter of this year, despite the continuous drop in the average price of satellite receiving equipment, and recent special offers.

The number of British households with satellite TV dishes grew by 27,000 to 3,054,000 during April 1995. This marks the first drop in what had been a slow but steady growth during the first 3 months of the year – 31,000 in January, 32,000 in February and 33,000 in March.

Contact: GfK Marketing Services, (01932) 354911.

RSGB Membership Changes

The Council of the RSGB has approved measures to reward long-standing members of the Society when its subscription rates change in September. Home Corporate members who have enjoyed 50 years of continuous membership will receive a 50% discount on their fee, while Home Corporate members who have enjoyed 60 years of continuous membership will be granted free life membership.

In addition to this measure, the RGSB is now offering a new Junior membership category. Young people under 18 years of age can join the HamClub for a fee of £10 per year. HamClub members will receive a Junior Membership pack, together with an annual subscription to D-I-Y Radio.

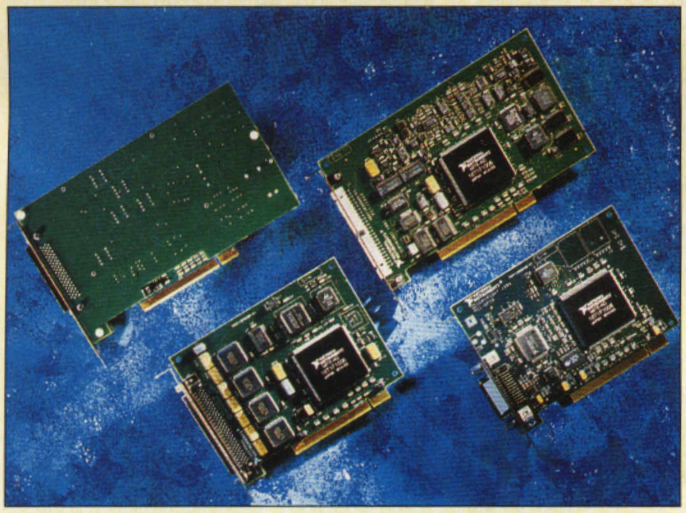
The Home Corporate membership fee will be increased from £32 to £34 per year, except for senior citizens, whose rate remains unchanged, at £27.

Contact: RSGB, Tel: (01707) 659015.

Apple-based Instrumentation

National Instruments has announced a series of data acquisition boards based on PCI (peripheral component interconnect) technology for the Power Macintosh. The boards are targeted at laboratory automation and process monitoring. Scientists already used National Instruments data acquisition products, in applications as diverse as sonar monitoring and mechanical engineering.

Contact: National Semiconductor, Tel: (01635) 523545.



PowerPC Alliance Bears First Devices

IBM and Motorola has unveiled two high-performance extensions to the PowerPC 604 line of RISC-based microprocessors. The new chips operate at 133 and 120MHz, offer performance that exceeds Intel's current Pentium offerings, and is comparable to the future P6 microprocessor.

IBM and Motorola have doubled desktop PowerPC chip performance in less than a year, and offer the first mainstream desktop microprocessor capable of achieving a SPECint92 performance rating of 200.

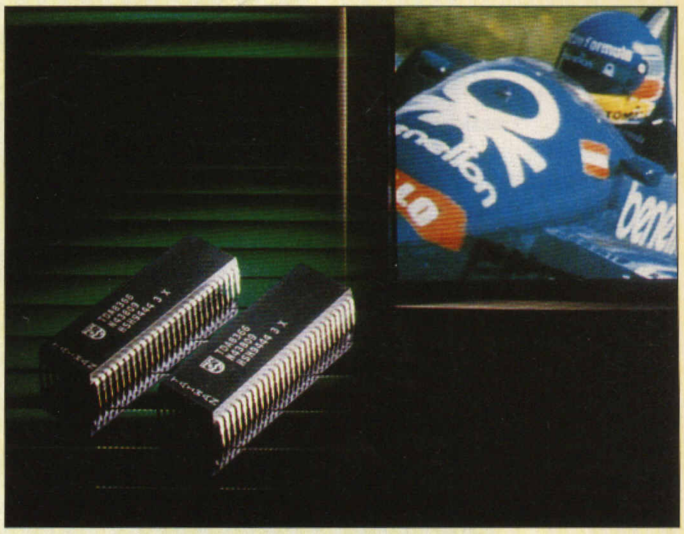
The 133MHz PowerPC 604 microprocessor has estimated SPECint92 and SPECfp92 ratings of 200, while the integer and floating-point ratings for the 120MHz version are both 180. Each microprocessor has dual 16k-byte instruction and data caches, a die size of 12·4 × 15·8mm and an IEEE-754 compliant floating-point unit. They each have 3·6 million transistors, and were designed using 0·5 micron process technology.

Contact: Motorola, Tel: (01355 565713); IBM, Tel: (01705) 563802.

Single Chip TV

Fully controllable via its I2C-bus interface, the TDA8366 single-chip TV processor from Philips reduces circuit alignment between the tuner and the CRT's drive circuits to a single tuned adjustment. Compared to other single-chip TV processors on the market, Philips claim that the TDA8366 achieves a superior reduction in peripheral count. High-performance functions incorporated into the new device include vision-IF demodulations, multi-standard PAL/ NTSC luminance and chrominance decoding, sync separation, picture control and deflection processing.

Contact: Philips Semiconductors, Tel: (+31) 40 72 20 91.



Memory Alliance Announces Record Performing DRAM

IBM, Toshiba and Siemens announced the first results of joint development work, reporting the smallest and fastest fully-functional 256M-bit memory chip ever developed. With a size of 285·5mm^2 (13·25 × 21·55mm) and a memory access time of 26ns, the new chip is at least 13% smaller, and has an access time nearly twice as fast as chips under development by other companies.

The smaller size and faster speed of the alliance device will enable future requirements of memory-hungry systems, such as powerful personal computers and workstations, as well as high definition digital video, multimedia and telecommunication systems. A smaller, faster chip means improved overall system performance and a reduced footprint necessary for memory on printed circuit boards.

DRAMs are fingernail-size silicon devices that store electronic data in products ranging from mainframe computers to home appliances. A 256M-byte DRAM can hold more that 16,000 A4 pages of double-spaced, type-written text.

Contact: IBM, Tel: (+33) 1 4905 8508; Siemens, Tel: (+49) 89 4144 8480; Toshiba, Tel: (01714) 455 2298.

Scanning Microscope

Kraemer Scientific Instruments has developed a PC-based Scanning Acoustic Microscope (SAM), to enable manufacturers to see through layered components such as semiconductors under development, and check bonded or interface layers for delaminations, cracks or adhesion problems.

The series SAM 100 is based on the principle of positioning a piezoelectric transducer above the specimen, using water and a voltage pulse to bounce back images off the sample, first showing layers and then displaying a 3D picture.

This action reveals any defects and imperfections, by either displaying a dark shadow or a bright reflection on the image produced on the monitor, caused by common problems such as trapped air bubbles or poor bonding, which normally destroy or shorten the life of the component.

Contact: (01794) 518183.

Out with the Old

BT has replaced its last mechanical exchange, at Crawford in Scotland, with computerised equipment. Over the last eleven years, the company has spent £20 billion overhauling its network of almost 7,000 exchanges.

Contact: Tel: (0171) 356 5369.

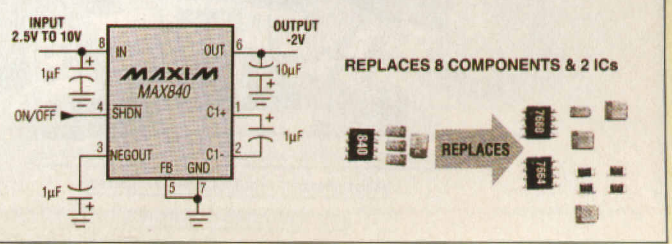
Generating Bias without Induction

The guys in the design laboratories at Maxim have been busy again. Amongst a clutch of chip releases this month, the company launched a family of record-breaking GaAsFET bias DC-DC converters. Maxim claims that the series of new devices beats its competitors on physical size, and both noise and voltage distortion.

The MAX840, MAX843 and MAX 844 charge pumps convert positive input voltages to low-noise negative outputs for biasing GaAsFET power amplifies in cellular RF transmitters. Packaged in 8-pin SOICs, the devices save space by using only three external 22µF capacitors and one 4µ7F capacitor. Output ripple is typically 1mV Pk-to-Pk, and guaranteed to be between 80 and 120kHz.

Contact: Maxim, Tel: (01734) 303388.

LOW-VOLTAGE, LOW-NOISE RF-TRANSMITTER GaAsFET BIAS SUPPLY IN ONE 8-PIN SOIC



CIRCUIT BREAKERS – Standby for Action!

Domestic cartridge fuses and circuit breakers are the electrical world's main guardians of safety. This article shows that while they do similar jobs, circuit breakers offer clear advantages over the more familiar, conventional fuses.

by Stephen Waddington

In common with fire extinguishers, seat belts and aircraft ejector seats, fuses and circuit breakers spend most of their existence doing nothing. That is, until something goes wrong. Then, their sole purpose is to protect people, livestock, equipment, buildings and installations from the considerable potential dangers of electrical faults.

Since 1864, fuses have been the most common form of circuit protection. Even now, fuses account for about 45% of the residential market. User benefits of circuit breakers include clear indication of a tripped circuit, simple resetting, protection against tampering, and residual current protection. Only time will effect the transition. The majority of new buildings are now fitted out with circuit breakers, to meet local authority regulations, and where an existing installation is rewired, circuit breakers usually take the place of cartridge fuses.

Let us not be too negative. Fuses perform a valuable role – it's just that circuit breakers can usually perform the same function to a higher level of accuracy, with an increased level of protection. Fuses protect solely against over-current. This may be caused by overloading a healthy circuit or by a short circuit. In either situation, the excess current flow will cause the fuse element (graded for normal operating conditions) to melt, breaking the electrical circuit it protects, as shown in Figure 1.

A collection of general-purpose circuit breakers.

Definitions

By contrast, circuit breakers are able to provide a higher degree of protection by monitoring not only overcurrent, but also earth leakage or fault currents. This leads us to two important distinctions, that of the residual current device (RCD) and the miniature circuit breaker (MCB). As we shall see later, a variety of other devices exist, but all can be traced in origin and functionality to either the RCD or MCB.

The Residual Current Breaker

In a healthy circuit, the current flow in the live and neutral should be equally matched. Figure 2 illustrates this scenario with a typical domestic appliance such as a hair-dryer. Clearly, the current flowing from the live into the appliance, should match that returning via the neutral. The socket-mounted circuit breaker will monitor the current flow within the circuit to

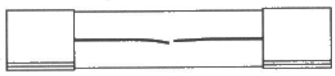


Figure 1. When subjected to a current greater than the rated value, a fuse wire within a cartridge fuse will melt, breaking current flow within the circuit.

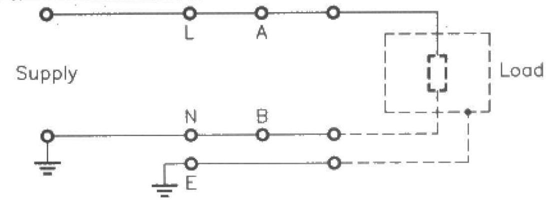


Figure 2. In a healthy circuit, the current flow in the live and neutral should be equally matched.

ensure that this is the case. If an imbalance occurs (possibly by current flow through a user to earth) the RCD will recognise this as an earth leakage current, and break the circuit.

Residual current device (RCD) is the generic term for circuit breakers able to detect earth leakage current. However, there are a variety of other devices and with them, abbreviations. Table 1 outlines the five most common classifications. RCDs are commonly used in conjunction with fuses or Miniature Circuit Breakers (MCBs) to ensure both over-current, short circuit and earth leakage protection. Alternatively, as we shall see, a residual current device with over-current protection (RCBO) can be used to achieve both ends in a single unit.

RCDs have been around for forty years or more. In fact, the principle of operation dates back to the days of Maxwell's left- and right-hand rules for magnetic induction and conversely, conduction. At the heart of the device is a transformer core, as shown in Figure 3. The load current is fed through a pair of parallel conductors in the RCD, which are wound onto the common transformer core. A detector winding or search coil is also wound onto the core, connected to the RCD's tripping mechanism via a solid-state amplifier.

When the live and neutral currents are balanced, they produce equal and opposite fluxes in the transformer core. If, however, they fall out of balance because of a fault condition, the fluxes generated in the core will register a current flow in the detector winding. This is amplified by the solid-state amplifier which then triggers a relay, so opening the mains contacts, and shutting off the power output.

The current level at which the detector coil triggers the tripping mechanism is determined by the rated tripping current

Type	Instantaneous Tripping Current	
	Multiple of rated current below which it will not trip within 100ms	**Multiple of rated current above which it will definitely trip within 100ms**
1	2·7 ×	4 ×
2	4 ×	7 ×
3	7 ×	10 ×
4	10 ×	50 ×

Table 2. Extract from BS3871, showing the tripping current for each MCB type.

Device		Description
RCD	Residual Current Device	Generic term for a whole family of devices.
RCCB	Residual Current Circuit Breaker	This type of RCD incorporates the contact system, tripping mechanism and sensing equipment in an integral case.
RCBO	Residual Current Breaker with Over-current Device	This type of RCD is an RCCB with integral overload and short-circuit tripping mechanisms.
SRCD	Socket Outlet with Residual Current Device	This device is intended for fixed wiring, and consists of a socket outlet with integral RCD protection.
PRCD	Portable Residual Current Device	This takes the form of either an adaptor, plug assembly or portable socket outlet, which contains, in addition to the socket, a sensing device to disconnect the device under fault conditions. Intended for use with appliances such as lawn mowers, hedge cutters and other hand-held equipment.

Table 1. The five most common circuit breaker classifications.

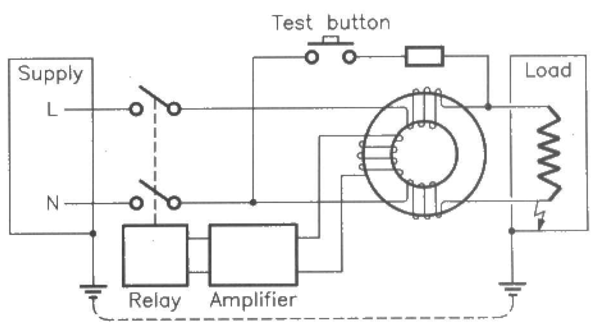


Figure 3. RCD schematic.

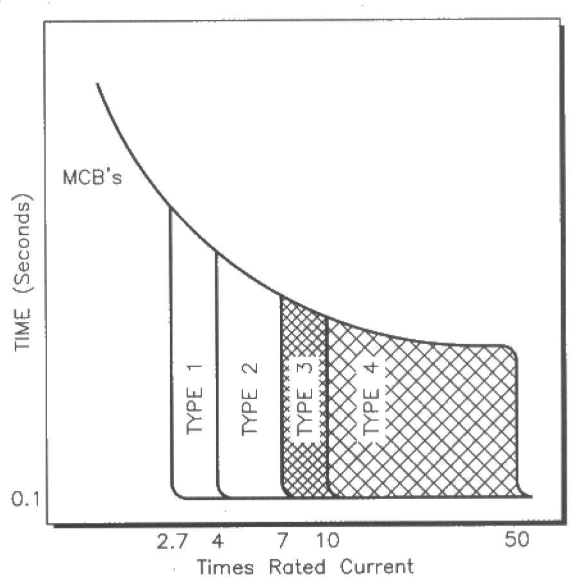


Figure 4. MCB characteristics.

of the RCD. To provide a high sensitivity and maximum personal protection, the IEE 16th Edition Wiring Regulations recommend that RCDs with a tripping current of 30mA should be used for domestic applications. This is particularly appropriate for portable appliances used outside, where there is a danger of moisture ingress, or loss of earth continuity due to damage or fatigue. Table 2 provides an outline of typical rated tripping current values of RCDs available in the UK, and their corresponding applications.

Although the operating principle of RCDs is described above in terms of a single-phase supply, the method applies equally to three-phase devices. In this case, the phase conductors, plus the neutral are wound onto the current transformer. Any unbalanced load current flowing in the phase conductors will be compensated by the neutral current.

RCDs always include a test device, so that the mechanical integrity of the device can be checked on a regular basis. This is arranged to create a simulated fault condition by bypassing one of the load windings. The magnitude of the subsequent fault condition is always limited by a resistor. Manufacturers typically recommend that the devices are checked weekly.

A common misconception is that an RCD is the ultimate in circuit protection. It is important to remember, however, that an RCD will only protect against earth leakage currents. Overcurrent protection must be treated as a separate issue. We have already seen how the function of an RCD and an MCB can be combined in a single unit to form an RCBO, but what if we require over-current and short-circuit protection alone?

Miniature Circuit Breakers (MCBs)

In this case, the role falls to the Miniature Circuit Breaker (MCB), and here lies the first advantage of MCBs over fuses. MCBs offer far greater tripping accuracy. Indeed, BS3871 Part 1, which covers MCBs up to 100A, provides for four classification types, according to the current at which each will operate instantaneously, as shown in Figure 4. Instantaneous in this situation, is defined as being within 100ms. Table 3 is an extract from BS3871, showing the tripping current for each MCB type.

This tight range of definitions enables an MCB to be selected with a characteristic precisely suited to the role intended. Compare this with fuses, where only a single tripping characteristic is available. For example, nuisance tripping can be avoided in applications where start-up surge currents are likely. Here, an MCB of a type able to withstand transient overloads can be selected, such as Type 3 or 4, as opposed to using an overrated fuse that would render the circuit vulnerable at other times.

Effective overload protection normally necessitates the use of a time-delay device which will enable harmless transient overloads to be tolerated, the operating time being inversely proportional to the magnitude of the overload. Whilst this time-delay feature is vital for small or mod-

Comparison of Fuses and Circuit Breakers.

Fuses	MCBs
Gases are all contained within capsule when the fuse ruptures, no external emissions.	If circuit breaker reacts to a short circuit it will vent dangerous gases. In the confines of a distribution panel this can cause arcing.
Not possible to tell if a fuse has ruptured without using test equipment (unless the fuse-wire is visible, or an indicator is provided).	Clear indication if an MCB requires restoring.
Good connection relies on an electrician pushing the fuse fully home.	A good circuit is guaranteed once an MCB has been installed and latched.
Once installed, fuses can be difficult to remove as contacts weld together and become reluctant to part. Problem is exacerbated over time, especially in a harsh environment.	Instances have occurred where MCB contacts have welded and internal mechanism broken. MCB can then indicate off when in fact, the contacts are made.
Either each electrical outlet or each distribution panel must be equipped with a fuseholder, so that fuse can be removed and replaced.	MCB simply requires the activation of a switch to reset.
Standard ratings across industry.	Non-standard ratings across industry.
Fuses can be tested to ASTA certification.	No certification body/procedure for MCBs, user has no assurance of performance.
Some manufacturers still solder fuse wire into fuse capsule. Can result in solder melting and fuse failing if fuse gets hot. A better alternative is to make a crimp or welded joint.	Time taken to establish circuit after failure is very short.
Fuse break can result in a circuit being down for some time, while new fuses are located and replaced. May affect other circuits while broken fuse is isolated.	No need to carry spares.
Good supply of spare fuses must be maintained. Fuse is simply renewed after failure. Restores circuit to ideal conditions.	Each trip degrades the operation of the MCB. Some manufacturers say an MCB should be replaced after three short-circuit faults. Very empirical, no authoritative guidance on this matter.
Fuses are able to tolerate switch-on surge currents.	Surge currents on switch-on can result in nuisance tripping.
Diversity factor required for fuse rating to prevent overheating.	MCB can be fitted as rated.
Fuse change may expose electrician to the inside of the distribution panel and bare contacts. (Bare contacts inside electrical equipment are now prohibited under the 16th edition of IEE Wiring Regulations.)	MCBs are mounted on the surface of distribution panel, therefore no possible exposure to mains.
Breaks only on excess current.	Will trip on both excess and leakage current.
Blown fuse prompts electrician to question why fuse has blown and investigate circuits.	First action is often to reset an MCB without due thought to the cause of the failure.
To isolate a circuit, electrician must either use isolation switch for whole panel or remove a single fuse.	MCB allows a single circuit to be isolated very quickly. Under 16th edition, MCB can be used a switch to isolate a circuit.
Established technology.	Relatively recent innovation.
Discrimination bands small, fuses available in a variety of values.	Discrimination bands are large.
Qualified electrician required to fit fuse.	Non-qualified personnel can reset MCB.
Fuses are available at rating above 600A.	MCBs are limited to ratings below 600A.

erate overload conditions, there should be no intentional time-delay in clearing very heavy overloads or short circuits. Under these conditions, tripping delays can be fatal. Consequently, normal domestic applications where surge currents are unlikely, call for the use of a Type 1 MCB, able to trip instantaneously (within 100ms) under fault conditions. With so many devices and combinations of devices available, it is easy to be confused. To help overcome this, Figure 5 shows a variety of practical configurations, and the level of protection each provides.

And There's More . . .

We have already seen that MCBs clearly hold operation benefits over fuses. The list does not end here. In domestic applications, the convenience of MCBs holds numerous advantages over the fuse. No particular skill is required to restore power once a fault has been removed, and since a high proportion of faults are either transient in nature or due to faulty equipment which can be unplugged, power can be restored with ease at the flick (or push) of a switch.

An intermittent fault will usually clear without assistance. If a fault persists, identification can be difficult and tedious. The cause of a residential circuit breaker tripping can usually be attributed to one of four faults outlined in the flow diagram in Figure 6. By following this process of elimination, it should be possible to identify the nature of the fault. It can be useful to observe switching actions prior to circuit breaker trips. For example, large inductive electrical appliances such as cooker elements or immersion heaters are a common source of intermittent fault due to surge currents and standing earth fault currents. Often such devices

Sensitivity	Application
300mA	Provides the means to achieve compliance with Wiring Regulations in conditions of poor earth loop impedance and also give a good level of fire risk protection.
100mA	Provides the means to achieve compliance with the Wiring Regulations, a high level of fire risk protection and a degree of indirect shock risk protection.
30mA	For use where a higher degree of protection is required, e.g., with portable equipment used in hazardous conditions.
10mA	Provides a high degree of personal protection, for use in sensitive areas such as laboratories, schools and workshops, where potential hazards exist from electrical faults through misuse, accidental damage or failure of electrical appliances.

Table 3. Typical rated tripping current values of RCDs available in the UK and their corresponding applications.

	COST EFFECTIVE	CONVENIENCE	DURABILITY	PERMANENT PROTECTION	CIRCUIT SPECIFIC	PORTABLE EQUIPMENT	FIXED EQUIPMENT
RCD ADAPTERS An RCD adapter fits between a three pin plug and a socket to protect a single piece of equipment such as a lawnmower.					X	X	
RCD PLUGS A three pin plug incorporating a RCD.		X		X	X	X	
RCD SOCKET OUTLET A fixed socket outlet with built-in RCD protection.		X	X	X	X	X	
RCD PROTECTED CIRCUITS A consumer unit with a main RCD protecting all circuits and MCB's protecting against overloads and short circuits.	X	X	X	X		X	X
RCD PROTECTED SPLIT BUSBAR CONSUMER UNIT A consumer unit with an RCD to protect specific circuits, such as socket outlets, but not others such as lighting.	X	X	X	X	X	X	X

Figure 5. Practical circuit breaker configurations and the level of protection each affords.

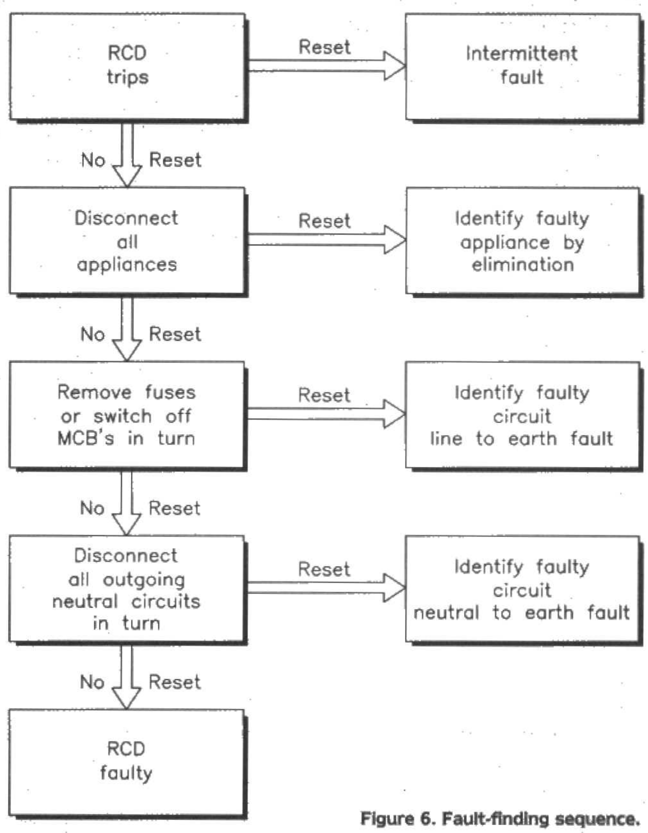


Figure 6. Fault-finding sequence.

Glossary of Terms

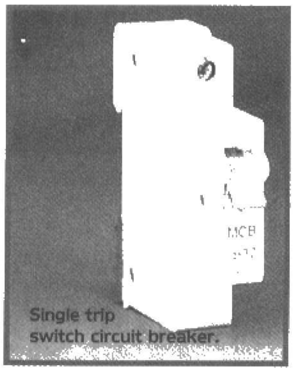
Cartridge fuse	A mains device comprising a fuse link enclosed within a cartridge. The fuse link is the part of the fuse which usually requires replacement after the fuse has operated.
Circuit breaker	An electrical device used to protect a circuit from excessive current and short-circuit, or identify earth leakage currents.
Earth	The conductive mass of Earth, the equipotential of which is taken to be zero. In a domestic situation, an earth connection is made to the consumer unit via an earth rod or electrode, buried deep within the earth.
Earth leakage current	A current which flows to earth, or to extraneous conductive parts, in an otherwise sound electrical circuit.
Overcurrent	A current exceeding the circuit's rated value.

demand a large switch-on surge current which may trip an MCB, followed by a standing earth leakage current once the element becomes hot.

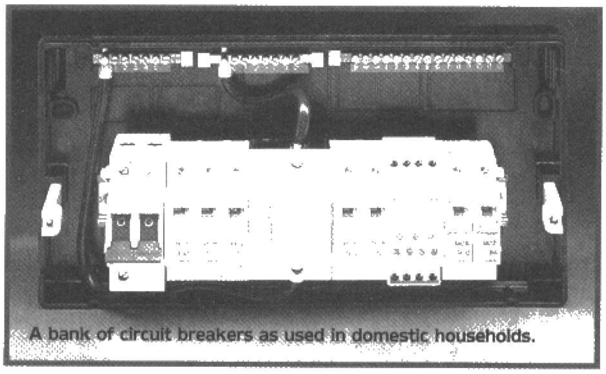
This outlines a clear advantage of circuit breakers – they can be reset with ease. Compare this with when a fuse blows. Here, an electrically competent person is required to isolate the entire distribution board, so that the fuse might be replaced in complete safety. This results of course, in the loss of power throughout a household while the blown device is replaced.

This highlights a further benefit of RCDs over fuses. When an RCD-protected circuit needs to be isolated, there is no need to cut power to the whole distribution board. Instead, the device protecting the circuit to be disconnected is identified and switched into the off position. This leaves all remaining circuits operational.

A final benefit is the tamper-proof construction of MCBs. When a fuse blows in a consumer unit, there is always a temptation to replace the burnt element with the fuse-wire that is closest to hand. Arbitrary uprating of fuses is dangerous, and can lead to fire risk due to overloading, and possible over heating. E

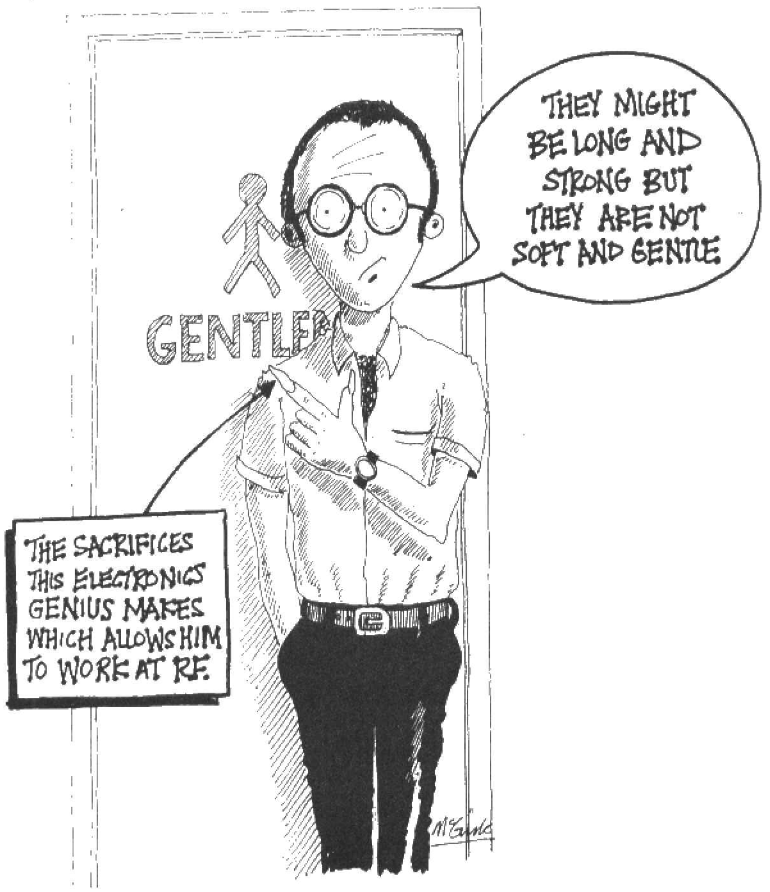


Single trip switch circuit breaker.


A bank of circuit breakers as used in domestic households.

Stray Signals

by Point Contact



Microminiaturisation

More and more of PC's work nowadays seems to deal with radio frequencies (RF). At these frequencies, especially VHF and above, stray lead and wiring inductance is always a nuisance, so the arrival of SMD (surface-mount devices) is an absolute boon. An 0805 resistor, eighty thousandths of an inch long by fifty wide, possesses negligible inductance, and the parasitic components associated with other SMD components are likewise, near negligible.

With components so small, there is obviously a handling problem – and indeed, a problem in actually *seeing* them. PC has never got on very well with a vacuum pickup, and so uses a pair of fine pointed tweezers to place a component, and then holds it down in place with the nail of his left forefinger, whilst soldering the other end in place. Once one end is soldered, the other end presents no problem, provided one doesn't get the component so hot that it re-melts the original joint. One long finger nail on its own looks a bit odd, so they are all kept at the same tidy length, leading in the past to PC being asked if he played the guitar!

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resulting in the board looking rather like it was covered by some very untidy knitting. Unfortunately, the exact values of some of the components could not be determined until the board was up and running, and inevitably, these components turned out to be the ones buried under the denser layers of knitting!

Younger engineers among readers will not have any trouble seeing components so small, the range of focus of the human eye (before reaching middle age) being quite incredible. For us oldies, there are several options. Either one can work under a binocular microscope, tedious to a degree, or just having to resort to a watchmaker's eyeglass – almost as tedious. PC's solution is an enormous 'addition' for the reading portion of his prescription glasses. Having years ago made the extremely worthwhile conversion from bifocals to vari-focal lenses, he recently presented his optician with some mid-grey plastic small-outline devices marked, as so often is the case, with grey printing of almost exactly the same hue. Having got the message, PC is now equipped with vari-focals where the reading portion is 3·25 dioptres stronger than the distance section. This enables him to read the values printed on 0805 and other components with ease (under a good light) – those of you who remember your A-level Physics will realise that this put things in focus at a shade under one foot!

Misnomers

You may recall my comments in a recent issue, concerning 'politically correct' (No. 85 – Ed.) speech. PC recently came across another such oddity; apparently, the opposite of 'disabled' is not 'able-bodied', but 'non-disabled'! That reminds me of another euphemism, which PC encountered as a National Serviceman in the RAF. Posted to a fighter station which had been a famous household name during the Second World War, PC had in his charge, a seldom-used Ford-engined 5kW petrol-electric set for powering Hawker Hunters when on the ground. Supposedly, he checked the oil, water, etc., daily, entering the results on a log sheet. Actually, it got done about once a fortnight, but that day, it had to be done forthwith, as the machine was due to go in for a minor-star service. To his horror, on looking inside the machine, it transpired that the starter battery was missing, a circumstance which correlated suspiciously well with a gang of civvy contractors who had resprayed the inside of the hangars the previous week. Fortunately, the sergeant in charge of our Radio Service Flight (after letting me sweat a bit to teach me a lesson) produced a battery clearly labelled '29 Squadron'. The label was quickly effaced and the (rather dud) battery installed in the PE set, just in time for its minor-star. Doubtless, 29 Squadron covered their loss in a similar manner, the arrangement being well-known in the Forces, under the term 'mobile deficiency'.

Tailpiece

Last time, PC mentioned that classic book for home wireless constructors, dating from the thirties. Full of ideas relating to the subject, some were more helpful than others. One of the daftest concerned coping with interference. The recommendation here was that you simply turn down the volume until the interference could no longer be heard!

Yours sincerely (from an NHS bed),

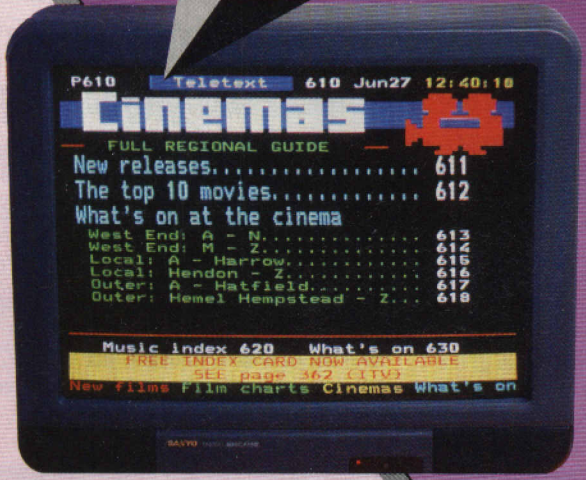
Point Contact

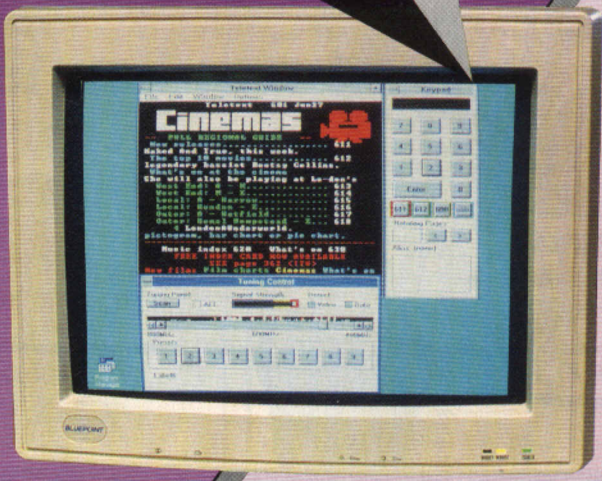
The opinions expressed by the author are not necessarily those of the publisher or the editor.

KIT AVAILABLE
(90035)
Price
£69.99 C1

IBM-PC TELETEXT DECODER FOR WINDOWS
INTERFACE CARD

Please note that a colour TV licence will be required for legal use of this project.





APPLICATIONS

* Home and work use
* Media related establishments

Design by Tony Williams
Technical support by Dennis Butcher
Text by Tony Williams and Maurice Hunt

PART 1

FEATURES

* Compact, efficient design
* Windows™ driven, mouse-controlled software
* Fits directly into PC expansion slots
* Built in Teletext decoder and PC interface with I²C bus and FPGA
* Operates from internal PC power supply

Television broadcasters have identified teletext as an important medium with which to present all kinds of information to the viewer – and significant audiences are beginning to develop. Over the last couple of years, services have been revamped, improved and altered beyond all recognition, and the sheer volume of up-to-the-minute news and information that is instantly available is now genuinely impressive, with teletext now available on all four UK channels. Even satellite and cable TV channels are being equipped with teletext services, making worldwide news and information available in seconds. Whatever your area of interest, it will probably be represented somewhere within teletext's electronic pages.

Specification

Power supply:	Uses internal PC +5V and +12V DC supply
Current consumption:	250mA maximum
PCB dimensions:	117399mm
Height of assembled card:	20mm maximum

The problem with conventional teletext is that it is somewhat awkward to use. You cannot print out a page containing useful information. It often takes a long time for a particular page to come along, and when it does, it suddenly disappears to be replaced by another! Need I go on? Well, most of these problems have been addressed somehow or other by the operators of modern teletext services and by the designers of modern teletext decoders, but what is really needed, is a tool with which to sort, store and manage the wealth of information that teletext puts at your fingertips.

Enter the humble personal computer. Many households are equipped with a computer of some

sort, and by far the most common is the IBM-compatible PC. Computers like these are ideal for the purpose of sorting, storing and manipulating information, and a PC-based teletext decoder would be an excellent tool for making the most of the worldwide teletext database.

PC-Based Teletext Decoder for Windows 3.1 or Higher

The unit presented here is intended for use with an IBM-PC compatible computer, equipped with Microsoft™ Windows 3.1 or higher. The design comprises three major sections, one of which is entirely optional. Figure 1 shows the block diagram of the overall system, whilst Figure 2 gives the functional block diagram of the Interface Card. A plug-in card fits into one of the PC's expansion sockets, and contains a teletext decoder and a PC interface. In addition, the card requires some Windows software to be installed on the computer. Finally, all teletext decoders require a source of video signal, and this system is no exception. You can either supply the PC card with composite-video taken from a video recorder or satellite decoder for example, or alternatively, you could build a dedicated television tuner to be used exclusively with the teletext decoder. A design for a compact, desktop television tuner, to provide the video IF signal (without the sound), which can be controlled from the software on the PC will be described in *Electronics* Instruction Leaflet (XV59P).

The design of the teletext decoder is based around two main components. The first is a dedicated teletext decoder IC manufactured by Philips Semiconductors Ltd., the SAA5246. This device might typically be found in a modern domestic television set, where it looks after every aspect of decoding and displaying teletext. In this application, many of its features (which mainly concern displaying teletext) are not used. Instead, information is passed back and forth between the device and the PC through an interface, known as an I²C Bus. (I²C Bus and I²C are Philips' trademarks). I²C is a two-wire microprocessor bus structure that was developed by Philips in order to reduce the many overheads that are associated with implementing microprocessor systems. Although it is not a particularly fast interface, from a manufacturing point of view, it is an incredibly simple one.

Philips' I²C Bus operates in a fundamentally different way to the IBM-PC's microprocessor bus, so some sort of interface is necessary, to act as a translator between the two systems. This interface has been built using a field programmable gate array (or FPGA) from a company called Xilinx. The FPGA is a type of programmable logic device, whose function is determined by a block of configuration-data which is loaded into it (from an external EPROM) each time the circuit is powered-up. The data stored in the FPGA's CMOS static random access memory (SRAM) was produced using Xilinx's FPGA software, and has been derived from several pages of schematic diagrams drawn with a modern CAD tool.

The FPGA (IC2), a 2,000 logic-gate XC3020, contains three main sections: the I2C Bus controller, an IBM-PC interface, and a tuning controller for use with the dedicated television tuner described later. The tuning controller consists of a 14-bit digital-to-analogue converter, with which the PC can adjust the tuner, and a signal strength meter, with which the PC can sense how clearly a station is

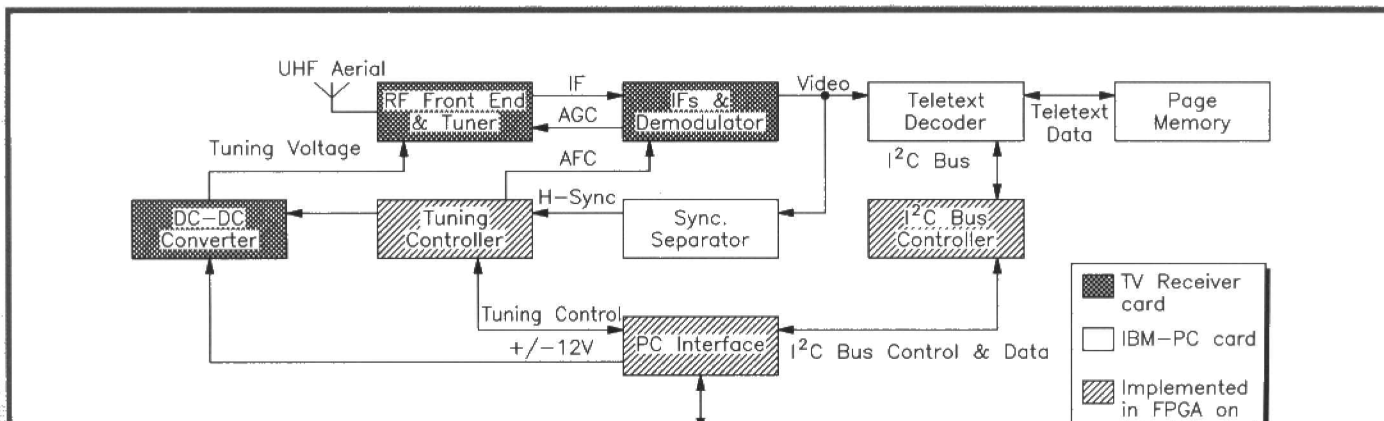


Figure 1. Block diagram of the overall PC Teletext Decoder system.

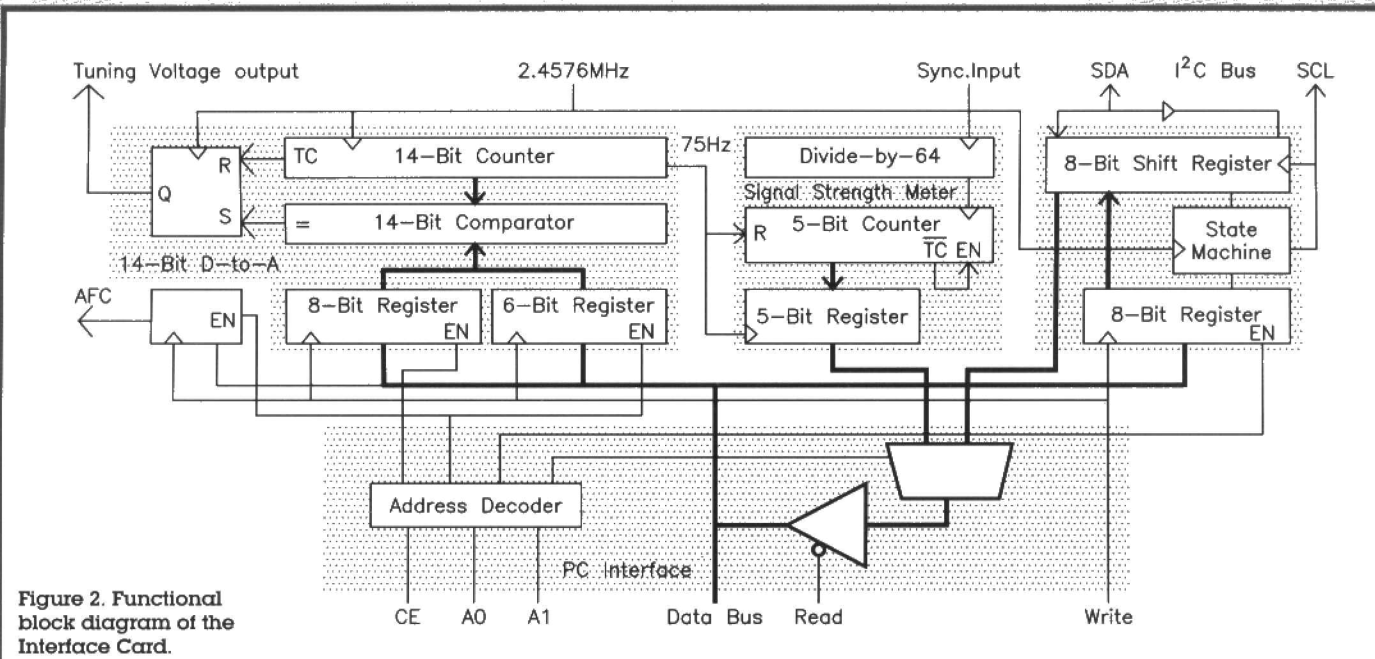
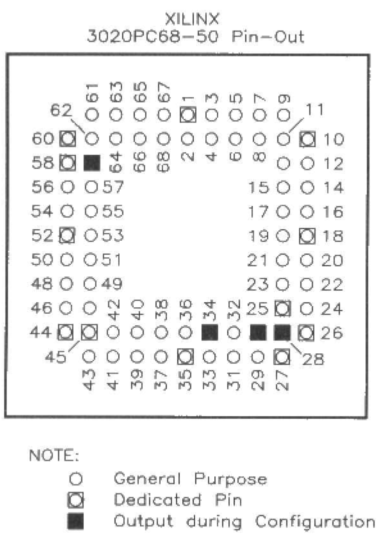


Figure 2. Functional block diagram of the Interface Card.

being received. The block diagram, depicted in Figure 3, shows how the various functions have been implemented within the FPGA.

The 14-bit D/A converter works by varying the duty-cycle of a 75Hz, 5V Pk-to-Pk squarewave on pin 54 of the FPGA. An external low-pass filter (formed around IC4, with a cut-off point of around 7Hz), converts this to a steady DC output whose voltage (in the range 0 to 10V) is proportional to the squarewave's duty-cycle. This 'tuning voltage' is used to set the tuner to the appropriate frequency, and a 'scan' mode is provided, with an indication of signal strength; white for a strong signal, red for a weak, noisy signal, and black for no signal present – see Figure 4, which shows a screen capture of the tuning control panel.

The signal strength meter works by counting the number of the horizontal synchronisation (sync) pulses that the video signal contains over a short period of time ($^{1}/_{75}$th of a second). The sync pulses are detected by IC5 and fed into the FPGA via pin 64. A strong, well-tuned television picture should have a precise number of horizontal sync pulses in any fixed period, and as the quality of the picture deteriorates, the increased level of noise causes the sync separator to generate additional, spurious sync pulses. These extra pulses cause the sync pulse-counter to reach higher and higher values as the noise gets worse. The value of this counter can be read by the PC, and is used to generate a bar-graph showing instantaneous signal strength; a full white bar indicates the strongest signal is being received, whilst all-black shows that little, or no, signal is being detected. Figure 5 shows the circuit diagram of the Interface Card, while Figures 6 and 7 provide the pinout details of the IBM-PC expansion connector and 9-way D-type socket, respectively.



PIN	PINOUT	SIGNAL	PIN	PINOUT	SIGNAL
1	GND	GND	35	GND	GND
2	A13–I/O	GND	36	I/O	D3
3	A6–I/O	N.C.	37	I/O	D4
4	A12–I/O	N.C.	38	I/O	D5
5	A7–I/O	N.C.	39	I/O	D6
6	A11–I/O	N.C.	40	I/O	D7
7	A8–I/O	N.C.	41	I/O	N.C.
8	A10–I/O	N.C.	42	I/O	N.C.
9	A9–I/O	N.C.	43	XTL2(IN)–I/O	XTAL
10	$\overline{\text{PWRDWN}}$	$\overline{\text{PWRDWN}}$	44	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$
11	TCLKIN–I/O	$\overline{\text{WR}}$	45	DONE–$\overline{\text{PG}}$	$\overline{\text{DONE}}$
12	I/O	N.C.	46	D7–I/O	N.C.
13	I/O	N.C.	47	XTL1(OUT)–BCKLIN–I/O	XTAL
14	I/O	N.C.	48	D6–I/O	SDA
15	I/O	N.C.	49	D5–I/O	SCL
16	I/O	N.C.	50	$\overline{\text{CS0}}$–I/O	N.C.
17	I/O	A1	51	D4–I/O	N.C.
18	Vcc	Vcc	52	Vcc	Vcc
19	I/O	AFC	53	D3–I/O	N.C.
20	I/O	N.C.	54	$\overline{\text{CS1}}$–I/O	TUNE
21	I/O	A0	55	D2–I/O	N.C.
22	I/O	$\overline{\text{RD}}$	56	D1–I/O	N.C.
23	I/O	$\overline{\text{WR}}$	57	RDY/$\overline{\text{BUSY}}$–$\overline{\text{RCLK}}$–I/O	N.C.
24	I/O	$\overline{\text{CS}}$	58	DO–DIN–I/O	DIN
25	M1–$\overline{\text{RDATA}}$	M1	59	DOUT–I/O	DOUT
26	M0–RTRIG	M0	60	CCLK	CCLK
27	M2–I/O	M2	61	A0–$\overline{\text{WS}}$–I/O	N.C.
28	HDC–I/O	HDC	62	A1–CS2–I/O	N.C.
29	I/O	SRX	63	A2–I/O	N.C.
30	$\overline{\text{LDC}}$–I/O	$\overline{\text{LDC}}$	64	A3–I/O	SYNC
31	I/O	D0	65	A15–I/O	N.C.
32	I/O	D1	66	A4–I/O	N.C.
33	I/O	D2	67	A14–I/O	N.C.
34	$\overline{\text{INIT}}$–I/O	INIT	68	A5–I/O	N.C.

N.C. Not Connected

Figure 3. Pinout of the Xilinx 3020PC68-50 FPGA IC.

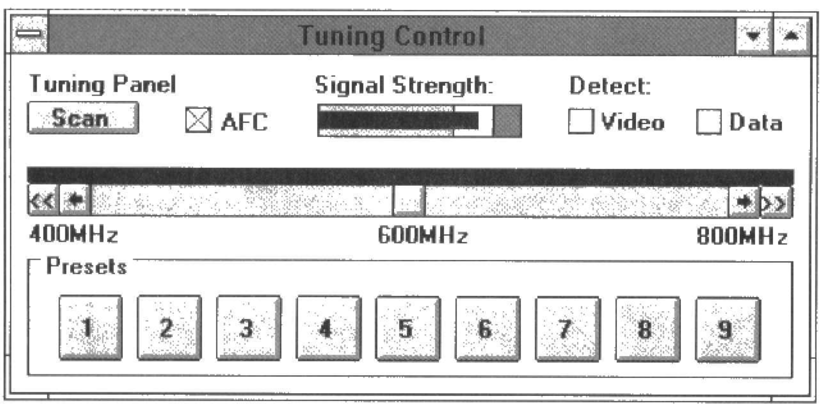
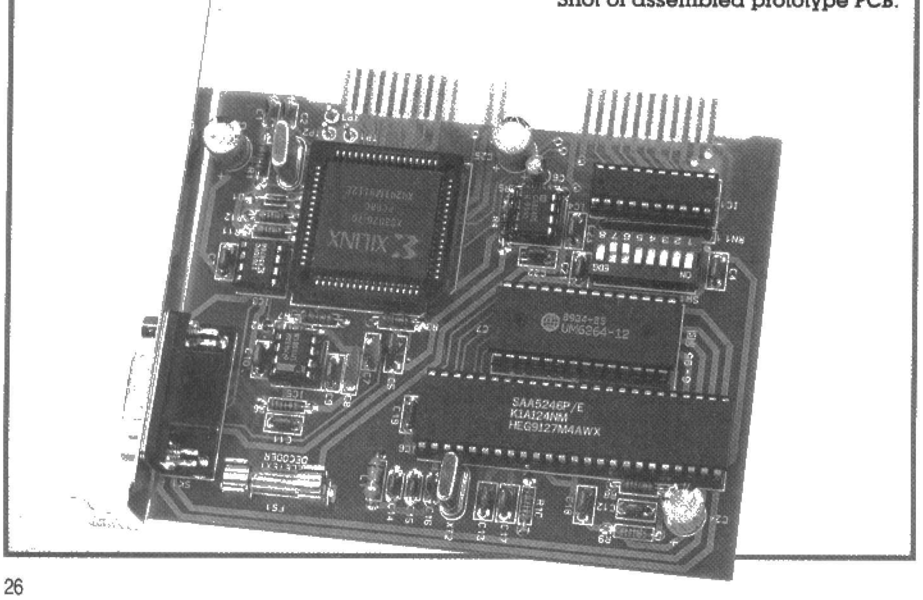


Figure 4. Screen capture shot of the tuning control panel.

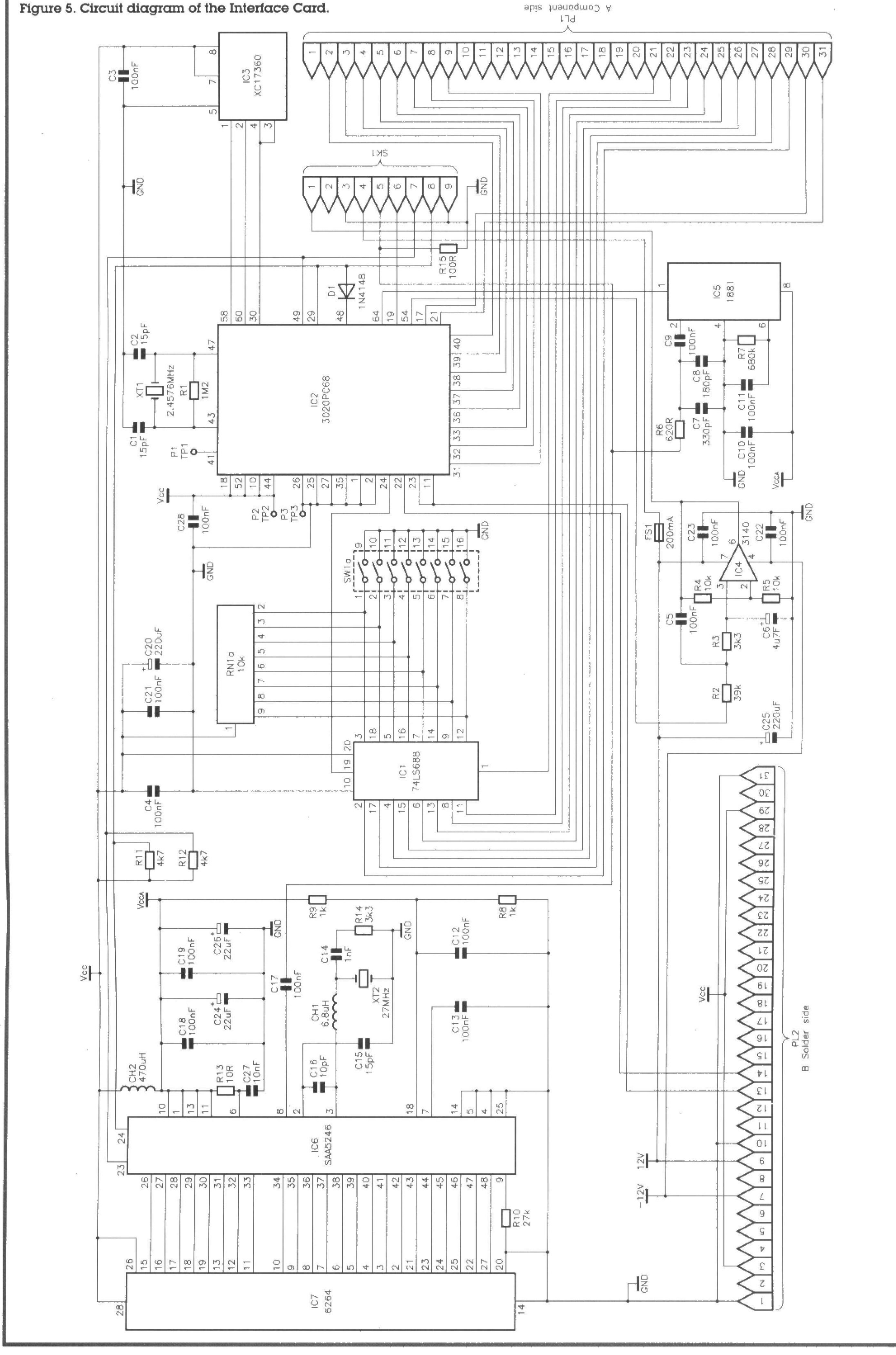
Shot of assembled prototype PCB.



Construction

Because the double-sided printed circuit board has a ground plane on both sides, you will have to be on your guard for accidental solder bridges to earth. Refer to Figure 8, of the PCB legend and track, during the PCB construction process. Build up the board, working in order of ascending component size, commencing with the resistors, diodes and capacitors, and SIL resistor pack (ensuring the correct orientation/polarity of the

Figure 5. Circuit diagram of the Interface Card.



latter three) before progressing to the IC holders and larger components. The resistor pack has a dot printed on one end, which should be nearest to pin 20 on IC1. Insert the seven IC sockets. IC6, the teletext decoder, is a 48-pin device and its socket can be constructed from two 24-pin sockets. Be careful to ensure that these two sockets fit closely together or you may have difficulties later when it is time to insert the device. Also, check carefully the orientation of the IC sockets for IC1 and IC4 as these point in the opposite directions to most of the others. When it comes to inserting the 68-pin socket for IC2 (the FPGA), be certain to get it the right way around. These sockets either have a shaved-off corner and/ or an arrow pointing to pin 1. The arrow should point towards the PC edge-connector, and/or the shaved corner should be top-left. Take your time soldering this socket, because the leads are closely spaced and there is considerable risk of solder bridges to other pins or to the ground plane. With the sockets in place, mount the rest of the components, leaving the two crystals and the big electrolytic capacitors until last.

One very important aspect of the construction of all PC cards, concerns the use of a metal mounting plate. The PC card has a 9-way D-type connector which pokes out of the rear of the PC's case, so that the tuner module or some other video source may be connected to it. A mounting plate must be fixed to the PC card because without it, while the card is sitting in the PC, there is nothing to anchor it firmly in place. Pushing a connector onto the 9-way D-type socket, for example, could easily be enough to push the card out of its expansion connector with disastrous results. The mounting plate supplied with this kit has been pre-punched and all you have to do is unscrew the two bolts on either side of the 9-way D-type connector (using a pair of long nosed pliers), push the body of the connector through the rectangular hole and replace the two bolts, as per Figure 9. Also, soldering both the 9-way D-type connector's mounting clips and all 9 pins to the PCB is strongly recommended, as this will give it the strength to withstand plenty of pushing and pulling in the future.

Finally, inspect your work carefully, checking both the component side and the solder side, for short circuits, mistakes or any suspect looking joints. Do not forget that any short circuits which go undiscovered could potentially damage your computer, so take your time!

Testing

For testing purposes, insert IC1, IC2, IC3, IC6 and IC7. Note that once IC2 (the FPGA) is in its socket, it cannot be removed without using a special tool, so once again, make sure that it is inserted the right way around.

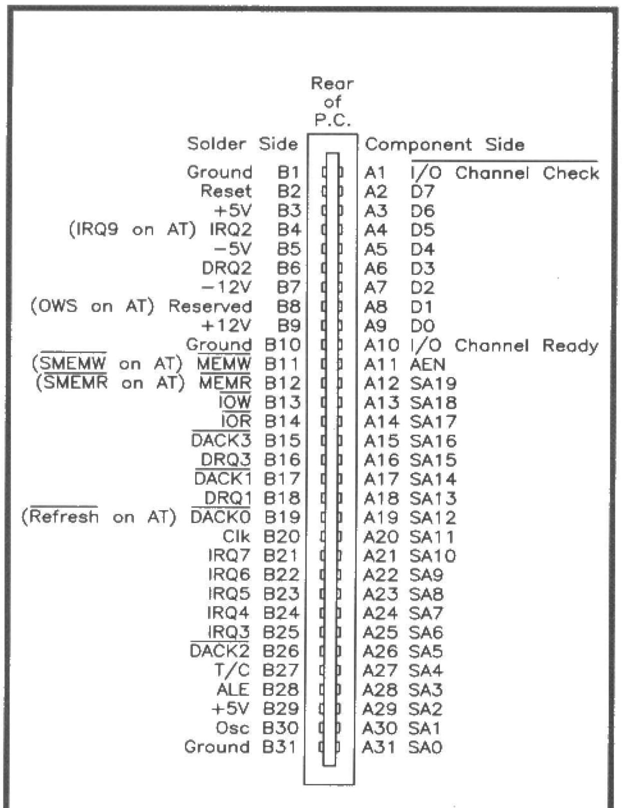


Figure 6. IBM PC expansion connector pinout.

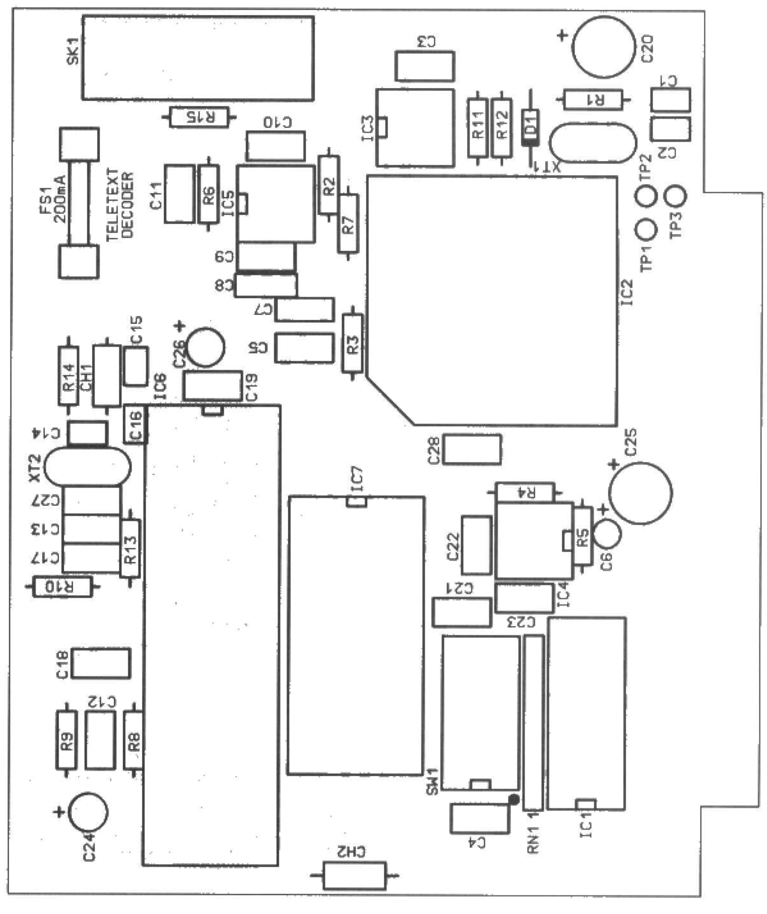


Figure 8. PCB legend and track.

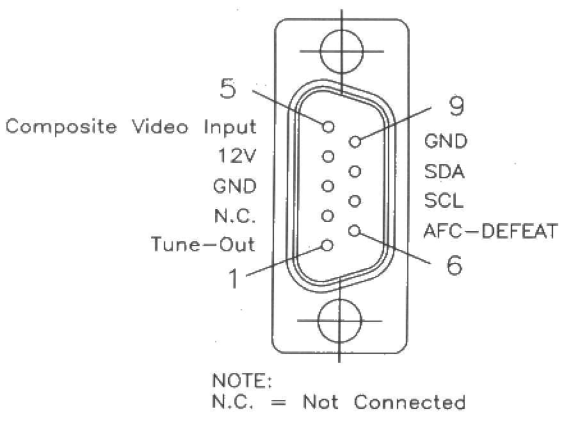
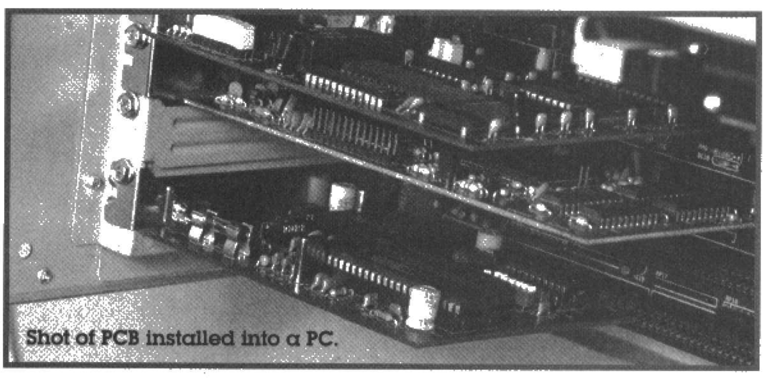


Figure 7. 9-Way D-type socket pinout.



Shot of PCB installed into a PC.

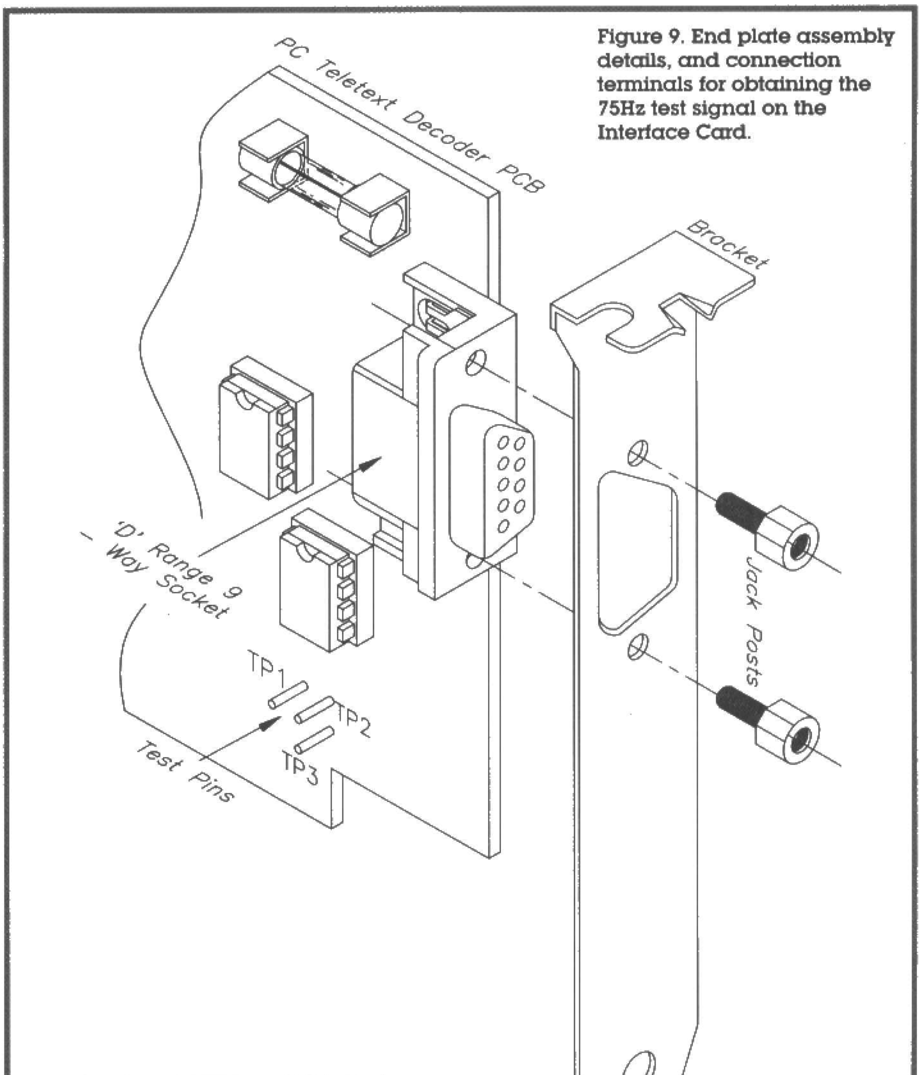
Holding the card with the PC edge-connector running along the bottom, you should be able to read the word 'Xilinx' running from left to right. We strongly recommend using a 5V 300mA, regulated power supply to power up the board, to enable it to be thoroughly tested, before putting it into a PC, since this will highlight any short circuits between the power rails and GND. Connect the GND lead of the PSU to terminal TP3, and the +5V lead to TP2, as shown in Figure 9.

Once power is applied, check that your PSU is not current-limiting. In this state, the board should only draw 250mA maximum; if it is significantly more than this, due to a short-circuit for example, then fuse FS1 will blow. Immediately after powering up, pins 3 and 4 of IC3 should both be at 0V. However, within half a second or so, they should go to around 3V or more. If this does not happen and/or IC2 begins to get warm, switch off the power and start investigating again. If things seem correct, then, using a frequency meter, an oscilloscope or even just an earpiece or small, high impedance loudspeaker, you should be able to detect a 75Hz square-wave at terminal TP1 (see Figure 9) – this confirms that the +5V and 0V supply lines are OK. This is just a test signal, and is not used by the rest of the design, but it must be present before the PC interface can be pronounced fit and healthy. If it does not appear to be present, then check that XTAL1, C1, C2 and R9 are all in place, and that the crystal's metal can is not shorting-out any tracks on the PCB. If all is well, then switch off the power, disconnect the test leads, and insert the rest of the devices.

Before plugging the card into your PC, check that the eight address switches are arranged in the following pattern: switches 1 to 5, and switch 8 are set to 'ON', whilst switches 6 and 7 are left in the 'OFF' position, as shown in Figure 10. This arrangement corresponds with your PC's (hexadecimal) I/O address 180_{16}. It is unlikely that any other cards within the PC will be using this address, but it is a possibility, so if things don't go smoothly later, try removing the rightmost jumper, which will move the teletext decoder to I/O address 380_{16}. In general, the I/O address can be selected as shown below.

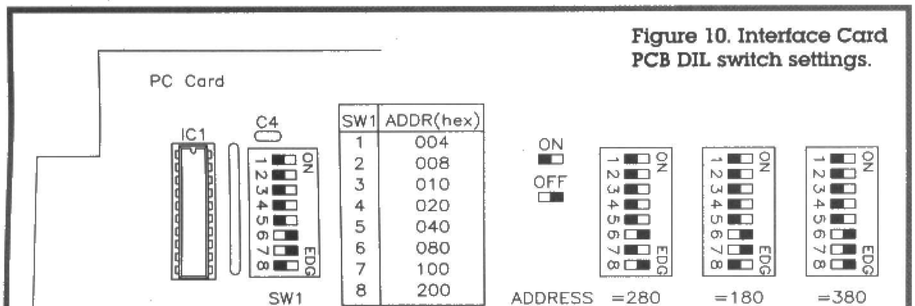
With the card plugged into the PC and firmly screwed in place, switch on the power and be ready to turn it off immediately if anything seems amiss. If the PC makes beeping noises, then there is probably a short circuit of some description on either the address, data or control busses, so power down the computer, remove the card, and re-examine these parts of the board. If the screen stays blank or is unstable, then there may be a short circuit on either the +12V or –12V lines. Hopefully, your PC will boot-up normally and leave you with the MS-DOS prompt "C:>". If this is the case, then you can perform a rudimentary test of the hardware by typing:

"18Ø" is the hexadecimal address of the teletext decoder in the PC's I/O memory map. If you have used a different jumper setting, then change this to the appropriate value; any address will do, though 18Ø should work well – if not, use address 3ØØ (the prototyping address). The number "58" is of no importance, it could be any 8-bit hexadecimal number, but the command "O 18Ø 58" writes this value into one of the FPGA's internal registers, and the command "I 18Ø" should successfully read it back. If you get back some other number,



TEST PIN DATA	
TP1	75Hz Test Signal
TP2	+5V
TP3	0V

Figure 9. End plate assembly details, and connection terminals for obtaining the 75Hz test signal on the Interface Card.



SW1	ADDR(hex)
1	004
2	008
3	010
4	020
5	040
6	080
7	100
8	200

Figure 10. Interface Card PCB DIL switch settings.

DEBUG	Hit RETURN	
O 18Ø 58	Hit RETURN	
I 18Ø	Hit RETURN	The computer should respond by displaying: 58
Q	Hit RETURN	

Table 1. Debug tests.

then there may be a problem. Try rebooting the PC and repeating the exercise. If it still fails, then use the DOS Debug program to check the board, or failing this, you may have to remove the card for further inspection. Check that both R19 and R20 are present, and that D1 has been inserted the correct way around.

Software

In order to test the system, you need to supply the PC card with a good source of composite video which contains teletext. (The output of a camcorder for example, would be no good.) The best solution is to use the composite video output of a video recorder, set to receive BBC1. To achieve this, you will have to make a small adaptor with a phono or BNC plug on one end (depending on the type of connector used by your video recorder) and a 9-way D connector on the other end suitable for plugging into the PC card. The PC card's video input is on pin 5 of the D connector, and earth is connected to pin 2. Satisfy yourself that your video-source is tuned in and receiving a good picture, and connect the lead to the PC card.

If everything is ready, then start Windows, insert the disk containing the Teletext Decoder software into drive A: and select the RUN option from under the Program Manager's FILE menu. In the dialogue box, type "A:\SETUP", whereupon the software will install itself. Whilst installing, the software creates a new group in the Program Manager called Teletext, which contains a new Teletext icon. Double-click on the icon to start the software.

The first time the software is started, it looks at I/O address 180_{16} for the PC card. If it does not find the hardware there, then it will ask you to supply another address (in hexadecimal). This address is stored away, and on subsequent runs, the software will look for there for the hardware.

Initially, the software appears as two windows; a teletext window and a remote-control window. Assuming that you have connected up a suitable source of video, the teletext window should be showing the time (according to whichever teletext service you are receiving) in the top right-hand corner. Click on the remote-control window's keypad to enter the number 100 and then click on the ENTER button. In a few moments, the teletext window should display the page you have requested. Figure 11 shows various screen captures, demonstrating the types of screen graphics you can expect to see when using this system.

Whilst reading the page you have selected, you will notice that at the foot of the teletext window is the message "Searching for rotating pages . . ." Rotating pages are teletext pages with the same page-number as the one you are viewing, but which have slightly different contents. They are typically transmitted every thirty seconds or so, and are the cause of the annoying ". . . but I haven't finished reading the last page yet!" syndrome. Instead of displaying these new pages immediately upon their arrival, the teletext software stores them up, and allows you to browse through them by clicking on the right and left arrow buttons on the remote control window.

Instead of selecting pages by clicking on the keypad-buttons on the remote control window, if a page-number appears on the teletext window, then you can request it by clicking on its middle digit twice with the right mouse button. The first click transfers the number to the readout at the top of the remote control window and the second click actually makes the request.

Alternatively, you can give any frequently used pages an alias. For example, you might give page 100 the alias "Index". You enter aliases by selecting the ALIAS option from under the WINDOW menu. A small window will appear, with which you can enter new aliases, edit existing aliases, save aliases to a file (for future use) or load predefined aliases from an existing file. Aliases should be entered in the following format: 100;Index or 101;Headlines, etc. Once aliases have been entered, they appear in an alphabetical list at the bottom of the keypad window, and you can fetch desired pages by double-clicking on their entries. When you have entered

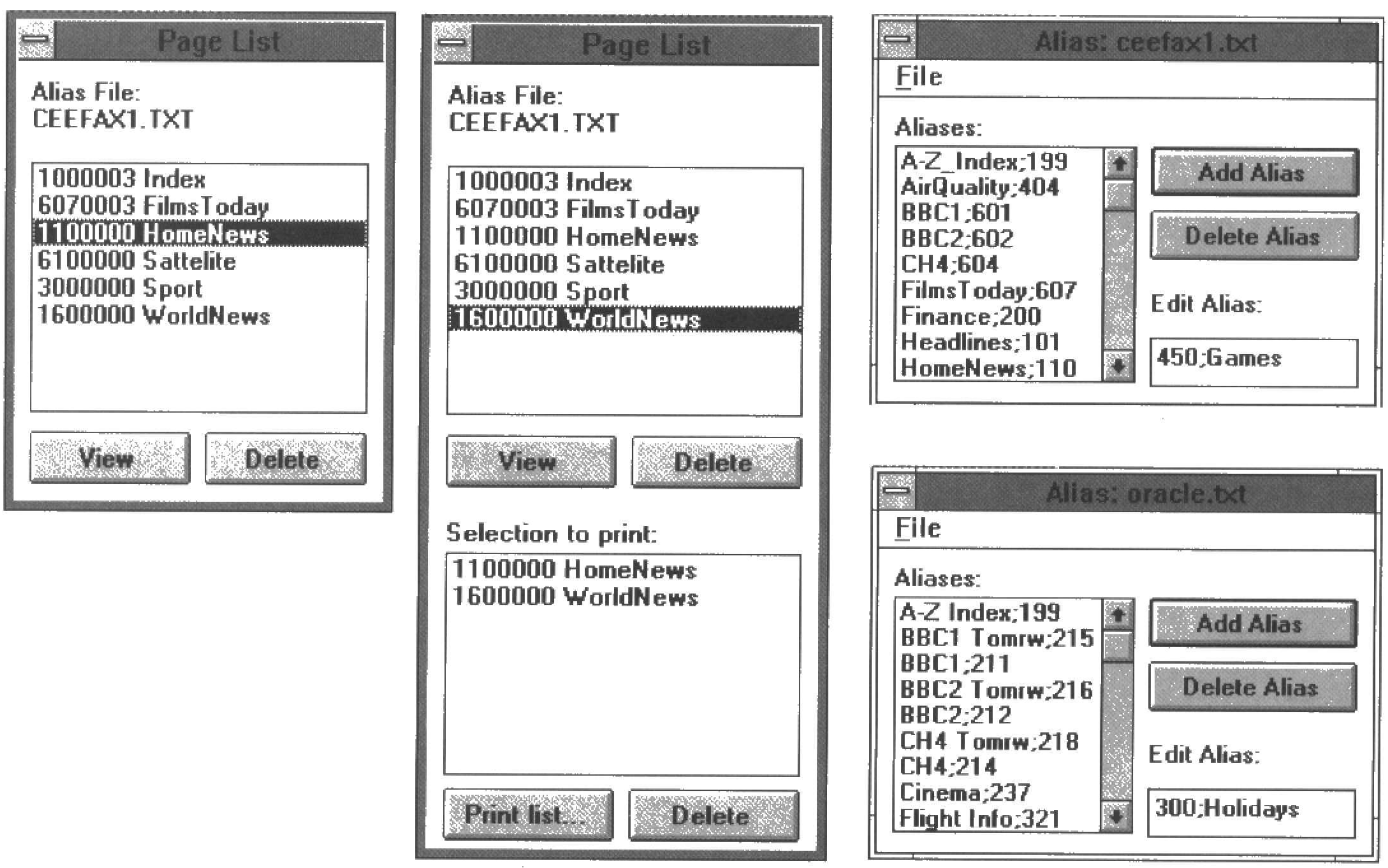


Figure 11. Screen captures of different options.

(or edited) aliases with the ALIAS window, remember to save them to a file if you wish to use them for later sessions. Also, because the different service operators all use their own page numbering schemes, you may find that you need several alias files, one for each channel. The examples below show one set of aliases for the BBC's CEEFAX service, whereas the other window shows a set of aliases for ITV's TELETEXT service.

If you see a page that you find interesting, then you can store it away for later use by pressing the S (or Save) button in the bottom left-hand corner of the teletext window. You can store many pages this way and browse through them later, by selecting the PAGE LIST option from under the WINDOW menu. The page list window displays the pages (and their aliases) that were selected earlier by pressing the S button on the main window. Entries can be viewed or deleted by choosing one (by clicking on it) and pressing either the VIEW or DELETE buttons. Note that both the page-number and its alias (if it has one) are displayed. The first three digits of the page number represent the page number as you requested it, and the remaining four digits, are its position within the rotation sequence, if it was a rotating page.

Once you have selected several pages, you can either save the collection to a file for browsing through at a later date, or you can print them. Close the page list window, and under the teletext window's FILE menu are the LOAD, PRINT and SAVE options. The SAVE option allows you to save this collection of teletext pages to a file for future reference, and the LOAD option allows you to retrieve a previously saved collection for viewing or printing.

The PRINT option brings up a window similar to the PAGE LIST, and asks you to select those pages which you would like to print. At this point, you can still view or delete any page, or by double-clicking on a particular page, you can add it to the list of pages to be printed. Finally, having selected those pages that you want to print, you can start them printing by clicking on the PRINT button.

The teletext window also has two other menus: EDIT and OPTIONS. The EDIT menu allows you to copy a region of text and/or graphics from the teletext screen to Windows' clipboard, for pasting into other applications – such as a word-processor. To select the area, hold the mouse-button down on the teletext window and drag the pointer across until the region that you want to copy has been highlighted. The selected region can be transferred to the clipboard by choosing the COPY TEXT TO CLIPBOARD option from under the EDIT menu. Note that the EDIT menu also has a FILTER option, with which you can choose to filter out certain characters. For example, you might like to transfer all the text on a page to a word-processor, but filter out all the graphics.

The OPTIONS window allows you to select a black and white, or colour display, hide the status bar along the bottom of the teletext window, and turn on or off the teletext window's autoredraw facility. This latter option controls whether or not Windows keeps a safe copy of what is being displayed on the screen somewhere else in memory. This has the advantage that if a window is ever covered-up by another, its contents are not lost, since they can be refreshed from the PC's memory.

The disadvantage is that whenever Windows has to draw something on the screen, it also has to draw a second copy to the image that it is keeping in memory. Consequently, on slower PCs, you may like to turn this option off. Note that if you do decide to turn autoredraw off, if a teletext page becomes corrupted, you can always refresh the window by clicking on the status button at the bottom of the teletext window.

PC TELETEXT DECODER – INTERFACE CARD PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)			
R1	1M2	1	(M1M2)
R2	39k	1	(M39K)
R3, R14	3k3	2	(M3K3)
R4,5	10k	2	(M10K)
R6	620Ω	1	(M620R)
R7	680k	1	(M680K)
R8,9	1k	2	(M1K)
R10	27k	1	(M27K)
R11,12	4k7	2	(M4K7)
RN1	10k SIL Resistor Array	1	(RA30H)
R13	10Ω	1	(M10R)
R15	100Ω	1	(M100R)
RN1	10k SIL Resistor Array	1	(RA30H)
CAPACITORS			
C1,2,15	15pF Metallised Ceramic	3	(WX46A)
C3,4,9-13, 17-19,21-23,28	100nF Monolithic Ceramic	14	(RA49D)
C5	470nF Monolithic Ceramic	1	(RA52G)
C6	4μ7F 35V Radial Electrolytic	1	(YY33L)
C7	330pF Metallised Ceramic	1	(WX62S)
C8	180pF Metallised Ceramic	1	(WX59P)
C14	1000pF Monolithic Ceramic	1	(RA39N)
C16	10pF Metallised Ceramic	1	(WX44X)
C20,25	220μF 16V Radial Electrolytic	2	(FF13P)
C24,26	22μF 16V Radial Electrolytic	2	(YY36P)
C27	10nF Monolithic Ceramic	1	(RA44X)
SEMICONDUCTORS			
D1	1N4148	1	(QL80B)
IC1	SN74LS688N	1	(KP49D)
IC2	XC3020APC68	1	(BH76H)
IC3	XC1736D MS03	1	(BH77J)
IC4	CA3140E	1	(QH29G)
IC5	LM1881N	1	(UL75S)
IC6	SAA5246	1	(BH75S)
IC7	6264 100ns	1	(UL01B)
MISCELLANEOUS			
CH1	6·8H RF Choke	1	(WH34M)
CH2	470uH RF Choke	1	(WH45Y)
XT1	2·4576MHz Crystal	1	(FY81C)
XT2	27MHz Crystal	1	(BH79L)
FS1	200mA 20mm Quickblow Fuse	1	(UJ76H)
	20mm Fuse Clip Type 2	2	(KU27E)
	Teletext Software MS09	1	(GV38R)
	68-pin PLCC Socket	1	(JC18U)
	9-way Right-angled D-type Socket	1	(FG25C)
	8-way SPST DIL Switch	1	(XX27E)
	8-pin DIL Socket	3	(BL17T)
	20-pin DIL Socket	1	(HQ77J)
	24-pin DIL Socket	2	(BL20W)
	28-pin DIL Socket	1	(BL21X)
	Single-ended PCB Pin 1·3mm (0·052in.)	1 Pkt	(FL20W)
	PCB	1	(90036)
	Instruction Leaflet	1	(XV58N)
	Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As 90035 (PC Teletext Decoder – Interface Card) Price £69.99 C1

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1996 Maplin Catalogue

PC Teletext – Interface Card PCB

Order As 90036 Price £14.99

ON TRACK WITH EUROSTAR

THE FUTURE IS HERE AND NOW!

From the moment you step on board the sleek, cyber-age Eurostar train (all quarter mile of it) at London's Waterloo International terminal, to your arrival in down-town Paris exactly three hours later, you are aware you are in a super train – one with class and style galore.

HAVING been welcomed on board by a bevy of smartly-dressed attendants, the train gently glides out of Waterloo and proceeds at a somewhat leisurely pace to Le Tunnel. Here, it speeds up to 60mph, but as you emerge at the other end, in France, the train really motors with the chief steward announcing "Nous roulons à 300kilos" – we're doing 186mph.

Carrying up to 800 passengers, the sleek, sexy design of Eurostar matches the passengers. Sitting in her lavender and grey first-class seat, international designer, Anna Scott remarked (whilst sipping a glass of champagne) "très si bon", as the train makes even the fastest Porsches on an autoroute alongside the track appear to be dawdling. "Travelling Eurostar is the ultimate 'feel-good' factor. No stop-go travelling to the airport; no being herded through endless corridors and terminals; no chance to stretch your legs on board the plane; no chance to relax or catch up on your work during the flight. Eurostar, however, provides plenty of time (and space) to get down to some serious, non-interrupted en route work. I cannot wait for the time when I will be able to try out the new London to Cannes Eurostar/TGV train door-to-door. This will be serious fun."

Anna should be warned, however, that her three hours of serious fun (and lavish supplies of champagne) will be reduced somewhat, once the high-speed network in the UK is in place. Then it will be possible to complete the London/Paris train run in under 2hrs 30mins. But, Anna needn't hold her breath. Eurostar reckon it will be at least the year 2002 before the new UK line is installed.

Letting Eurostar Take the Strain

Getting that feel-good factor, however, was no easy task for Eurotunnel, the organisation responsible for building the Channel Tunnel. The project was launched way back in 1981, with digging actually commencing in late 1987. The tunnelling itself was completed in 1993, with Eurostar high-speed test-running in France starting in 1994. Next year will see the completion of the new Belgian High Speed Line, which will reduce the current journey time London/Brussels from 3hrs 15mins to just 2hrs 40mins.

1 Food and beverages may be served at your table.

2 Alternatively, you may wish to visit the bar/buffet whilst on board.

3 The Eurostar train alongside the platform at Waterloo (Int'l Station).

4 There is generous space provided for travellers to enjoy a relaxed journey.

Eurostar trains operating between the three capitals are electrically powered and just under 400m long, they consist of a power car at each end, and 18 coaches. The trains are articulated and fitted with pneumatic suspension, with bogies located between coaches. In the event of an emergency in the Tunnel, the trains can be uncoupled at three points. Overall, the advanced suspension system and continuous welded rail ensures that noise is eliminated at source.

Eurostar trains are at the leading edge of technology. They work on three different power supplies and four different signalling systems. The trains have been designed to run on the infrastructure of three different national railway systems and in Eurotunnel, making them the first truly European high-speed trains. Their cross-section has to be compatible with the loading gauge of each of the systems over which they run, and to take account of different platform heights.

To reach and maintain the speed of 300km/h on the high-speed lines, Eurostar is fitted with electric induction motors on each of the power car axles and on the first two axles of each end vehicle, on the power car side. A total of 12 motors develop a traction power of 12,000kW, which is only used on the new high-speed line. On traditional lines, the limits are set by the performance of the electricity supply systems used. Since the induction engine does not have a rotor coil, it is particularly robust with a high power-to-weight ratio, hence its success in all industrial applications.

However, its use in railway traction poses specific problems, because of the need to provide current at variable frequency and voltage: very considerable variations in speed and load characterise the railway traction motor, compared to a much more constant stress which is found in industrial applications. It has only been possible to make this really rapid advance with the development of very high-performance power semiconductors (thyristors, gate controlled GTOs) which need complex devices to control them.

Power Me Up Scottie

Furthermore, the traction motors and their reduction gearboxes which provide the transmission to the axles, are mounted directly below the underframe of the power car. This arrangement, which reduces the size of non-suspended masses, improves the dynamic behaviour of the train, and its impact on the track. However, the main development bugbear has been that of the electrical power supply:

- 750V DC (third rail), with power collection by means of retractable shoegear from the third rail on the southern part of the UK rail system
- 25,000V AC (catenary) on the new high-speed lines in France and Belgium, in the Channel Tunnel and on the conventional lines north of London in the UK (for Eurostar trains operating the beyond London services)
- 3,000V DC (catenary) on conventional SNCB lines.

In Control

As with the SNCF's TGV Atlantique and TGV Reseau, the Eurostar driver's position is equipped with a screen and a keyboard, by which the driver can access an on-board computer for information on the condition of the train, how to correct possible equipment failures and what restrictions might apply to its operation in a given condition. This information may also be sent by radio directly to the control office. The control office can thus inform the maintenance centre if there has been an incident, enabling the repair staff to begin preparing the work to be done before the train even arrives.

An on-board signalling system, called TVM 430, is designed to pick up and decode data sent by beacons or in the rails. The TVM 430, also features a cab display indicating the speed limits to be observed by the driver. It plots a speed control curve, and applies braking to the train if the prescribed speed is not observed. Called 'cab-signalling', this technology was used because it is impossible to use visual trackside signals at high speeds, since the driver does not have the time to read the positions indicated. This has also been used for the signalling equipment in the tunnel.

The faster a train travels, the more efficient must be the braking system. Basically, there are two braking systems installed on the Eurostar:

- On the trailer bogies, braking is achieved through the friction of brake pads applied to four brake disks mounted on each axle
- On the motor bogies, by the action of the traction motors functioning as generators, and through the friction of brake pads on the wheels. The current produced by the traction motors is directed to a rheostat, where it is dissipated.

The advantage of this system is that the wheels absorb less energy, effectively increasing their life span. This type of rheostatic braking is independent of the presence of power current.

Trains of Thought

At the present time, Eurostar in Belgium makes use of the existing line. But from 1997, it will travel on a new line between the French border and the outskirts of Brussels. In Great Britain, the existing infrastructure is being used, thanks to the inability of the Government to make a decision on a fast rail route. This is not the case of course, in France, where a new high-speed track is already in operation. In fact, France is already planning an even faster main line route, from Paris to Le Tunnel.

At least, London can be proud of its new international terminal at Waterloo. The modern design, with its graceful glass and steel roof, is supported on a network of tubular trusses. The terminal, which is designed to handle up to 6,000 passengers per hour in peak periods, has been awarded with the Mies van der Rohe Pavilion Award for European Architecture and has the same sleek, exciting and sexy lines of the Eurostar train itself.

Tribute to Ticketing

Tribute is the name given to the new £17 million ticketing system. For the first time, one single computerised display screen will access details of Britain's 15,000 daily trains, more than 800 million fare combinations, and 12 million seats. International travel tickets and reservations are combined onto a single document card, for simplicity and speed.

Fare and timetable enquiries, availability, train accommodation requests and allocations, payment details, accountancy and printing of travel documentation, are simple and quick. Transaction times are halved for tickets with seat reservations and complex journeys. The range of seats remaining for sale in each of the fare categories is accessible to the travel agent, with timetables and availability being displayed together. By supplying a seamless and 'one-stop' service, The PA Consultancy who were responsible for developing the system, say that it will maximise the satisfaction of both staff and passengers using Eurostar.

Computers have also played a part in helping Eurostar drivers improve their English. An innovative PC-based training programme is employed, which uses advanced voice recognition techniques to improve their English pronunciation on the radio and test their knowledge of British security procedures. But, whether the system designer, The Hoskyns Consultancy, will make the PCs available to passengers to help them brush-up on their French whilst speeding across the continent, is unknown.

At the same time, all the train crews go through intensive training courses – training for once being the operative word. The team of international drivers take the Eurostar trains all the way from one capital city to the other, having had close encounters of a sophisticated simulator kind on a specialist course in France.

What no Beer (or Champagne)?

But not all is plain sailing (or rather, training) with Eurostar. Unlike the airlines and ferries, Eurostar passengers do not have access to any duty-free facilities. This is surely a misguided attitude by the Eurostar operators and presumably the UK government, who despite EC approval, have given duty-free sales the thumbs-down. This negative attitude could well rebound on the operators when the word gets around.

Hopefully, by next year, when Eurostar night services to Glasgow, Plymouth and Swansea to Paris commence, duty-free matters will have been sorted out. The new night trains are being described as hotels on rails, with plush, uncramped bedrooms, en suite bathrooms, bedside telephones, and Belgian chocolates on the pillows (at least Anna will be content). Later this year, will see the Eurostar service being extended beyond London. Services are planned to run between Waterloo, the North, the Midlands, the West, and South Wales.

Paying the Cost

Eurostar fares are not exactly in the basic economy bracket, but are competitively priced with airline travel. Normal standard-class return from London to Paris comes in at £77, while first-class costs £195. There are, however, several fare mitigating reductions, such as advanced booking and concessions for young and old passengers, and with ten trains a day to Paris and five to Brussels, there is no shortage of opportunity.

Enter our Fabulous Eurostar Competition!

In fact, there could be more opportunity than you think. You could find yourself sitting next to Anna – not to mention Naomi Campbell or Michael Douglas. Don't take our word for the elegant Eurostar train, enter and win the fantastic *Electronics* contest, and you could win a free 1st class return trip from London to Paris!

Also, two fortunate readers have the chance to win standard return tickets for themselves, their car and passengers on board Le Shuttle – the Eurotunnel service which runs between the terminals at Folkestone and Calais. This is the high-tech way to travel – journey time is only 35 minutes, and there are full duty-free and refreshment facilities at both terminals. Booking is not required, you just roll up and within minutes, you and 179 other cars are travelling at 87·5mph through the tunnel. There is separate rolling stock for coaches and trucks, which travel in single-deck carriages, unlike car, which are loaded into double-decker carriages. During the journey, you can get out of your car, tune into the special Le Shuttle FM Radio station, or watch the visual display screens within the carriages.

For the technically minded, each Le Shuttle is powered by two 7,600 horsepower locomotives, one at each end. These electric locos, among the most powerful in the world, are each capable of powering Le Shuttle individually. The shuttle is powered by 25V overhead cables, with power being generated from both sides of the Channel on separate, duplicated circuits, in case of power loss from one side. For extra dependability, Eurotunnel also has its own standby auxiliary power.

The cost of travelling on the new, fast and easy way to cross the Channel, varies between £65 and £99 for a day return, £115 to £169 for a short break (five days or less), and £214 to £308 for a period return.

Climb Aboard for a Chance to Win More Prizes!

However, that is not all! We also have six sets of four tickets for the exciting Eurotunnel Exhibition Centre, nearby the UK Channel Tunnel terminal at Folkestone. The prizes (which are worth £15.80 to each of the six lucky winners) are the ideal way of finding out more on how the Channel Tunnel system works. The hands-on, interactive exhibition features a giant model railway, depicting in minute and accurate detail, the two Eurotunnel terminals and the trains, plus an opportunity to try your hand at being a train driver in a full-sized mock-up of a driver's cabin. There is also an observation tower, which offers a panoramic view of the terminal – a veritable train spotter's paradise! E

eurostar Competition

Has *ELECTRONICS* Got News for You!

ELECTRONICS – The Maplin Magazine can let you experience the trip of a lifetime!

Yes! The prize for the winner of this month's competition is first-class return travel for two on the fabulous eurostar train, from London to Paris. including full champagne meals on board. (Normal first-class fare £195.00 each.)

PLUS, we are also giving away two period return tickets for you, your car and passengers on the Eurotunnel Le Shuttle.

AND, there are six runner-up prizes to be won. Courtesy of Eurotunnel, we have six pairs of tickets to the exciting Eurotunnel Exhibition Centre, close-by the Tunnel terminal at Folkestone. The Exhibition Centre provides a comprehensive picture of the Eurotunnel project, with displays, models and games. Overlooking the Folkestone Terminal site, the centre has a viewing platform, allowing visitors to watch the Euro trains go by. A 32m long model railway demonstrates both terminal operations.

All you need to do to enter the contest, is to correctly answer all four questions and send your answers on a post card or back of a sealed-down envelope to: **Eurostar Contest, The Editor, *ELECTRONICS – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR.**

Your answers must be received by 31st October 1995. The winning prizes, which must be taken-up by March 1996, will be issued subject to availability. Good Luck and happy travelling!

Please note that employees of Maplin Electronics, associated companies and family members are not eligible to enter. In addition, multiple entries will be disqualified. The prizes will be awarded to the first all-correct entries drawn. The Editor's decision will be final.

Questions

1. Where does eurostar enter the Channel Tunnel?
(a) Folkestone.
(b) Leicester Square.
(c) Canterbury.
(d) Stonehenge.

2. Eurostar trains are driven by:
(a) Diesel.
(b) Solar units.
(c) Electric power.
(d) Euro paraffin.

3. On the London to Paris eurostar route, where is the first stop?
(a) Clapham Junction.
(b) Paris.
(c) Lyons.
(d) Milton Keynes.

4. Which capital city does eurostar NOT (as yet) serve?
(a) Rome.
(b) London.
(c) Paris.
(d) Brussels.

5. What is the journey time through the tunnel for Le Shuttle?
(a) 10 minutes.
(b) 1 hour.
(c) 1 hour 5 minutes.
(d) 35 minutes.

NOISE! What is it, and Why?

PART FOUR
Noise Measurement

by J. M. Woodgate B.Sc.(Eng.), C.Eng., M.I.E.E., M.A.E.S., F.Inst.S.C.E.

In this series, we have looked at the fundamental theory of noise, the sources of noise in circuits, and how the circuit configuration affects the noise performance in terms of the signal-to-noise ratio (SNR). In this final part, we consider how to measure noise signals, which is a surprisingly detailed subject, and one which is often considered mysterious.

Bandwidth

Recalling the basic Nyquist equation for thermal noise:

$$P_n = 4kTB$$

Where P_n is the noise power in watts, k is Boltzmann's constant, $1{\cdot}38 \times 10^{-38}$ J/K (joules per Kelvin) and B is the bandwidth in hertz, we can see that the noise power is proportional to the bandwidth, and Joule's Law, shown by the equation below, shows that the noise voltage, which is what we normally measure, is proportional to the square root of bandwidth:

$$V_n = \sqrt{P_n R} = \sqrt{4kTBR}$$

This means that if we measure the noise with an inappropriate bandwidth, the answer will be wrong. If, for example, we tried to measure the noise output voltage of a video camera with the lens cap on, having significant components up to 5MHz, with a digital multimeter having a bandwidth of perhaps 20kHz, the result would be far too low, in principle by the square root of the bandwidth ratios, i.e. by a factor of 15·8. Now, it could be argued that if the measuring instrument has a much wider bandwidth than the equipment being measured, it measures all the noise output, so everything will be OK. Unfortunately, this is not true – usually we are not interested in any noise output which is outside the *useful* bandwidth of the *system* (not the particular piece of equipment). For example, a Hi-Fi power amplifier may well have a bandwidth in e xcess of 100kHz, but we are not interested in any noise which the loudspeaker cannot reproduce, and which we could not hear, anyway. We have, however, to put in a further reservation, which is that the *out-of-band noise* is not so strong that it could affect or even damage equipment (such as a tweeter) connected further down the signal path. In this case, we are very interested in it, probably because we need to redesign the offending equipment!

Audio Noise Measurements

There are three main standard ways of measuring noise in audio, and there are important differences between them. The simplest way just involves controlling the measuring bandwidth by means of a specified flat-topped response band-pass filter, in principle to the conventional audio bandwidth of 20Hz to 20kHz, but for historical reasons connected with filter specifications, the actual bandwidth is specified as 22·4Hz to 22·4kHz. The minimum rates of cut-off at both ends are also specified (see Figure 10). This filter should be used in conjunction with a true rms voltmeter, but for comparative measurements (e.g., what does the noise do if I replace a 741 op amp by an NE5534AN) an average-responding meter will do. This method of measurement is variously called 'ITU/R unweighted', 'CCIR unweighted', 'IEC268 unweighted' and 'BS6840 unweighted', often accompanied by the description 'band-limited', which is now easy to understand.

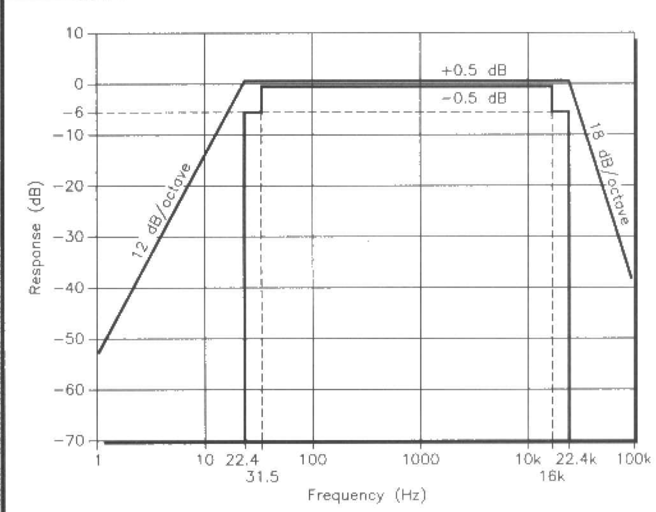


Figure 10. The specification of the IEC/ITU/R noise band limiting filter.

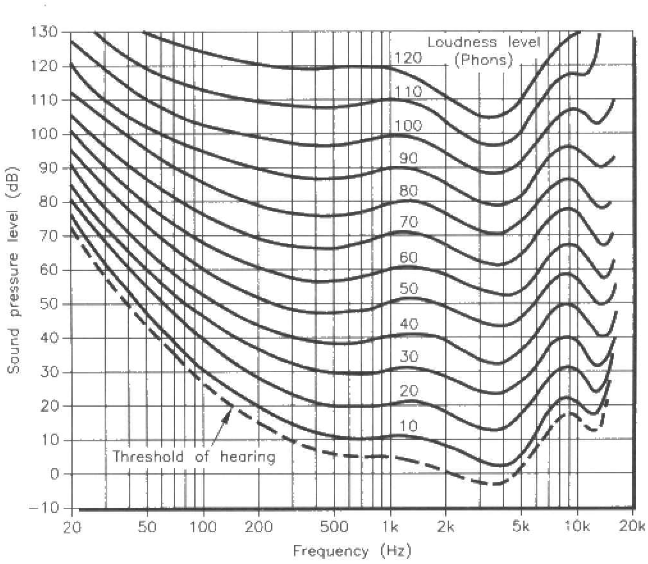


Figure 11. Robinson-Dadson equal-loudness contours.

(I hope!) The significance of 'unweighted' will be apparent from the following sections.

A-weighted Measurements

When we listen to white noise, which has equal energy in each 1Hz bandwidth, we find that the high frequencies seem to dominate – the sound is a hiss rather than a growl, especially if the sound level is low. This is due to the fact that the frequency response of the human ear varies with sound pressure level, and this effect is usually illustrated by the 'Fletcher-Munson equal-loudness contours', the first published family of curves showing the sound pressure levels required to produce sounds judged (by panels of

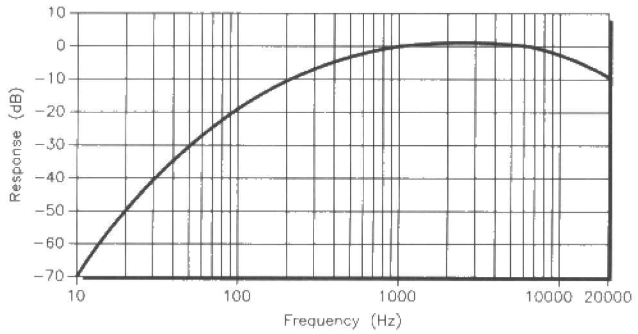


Figure 12. A-weighting curve.

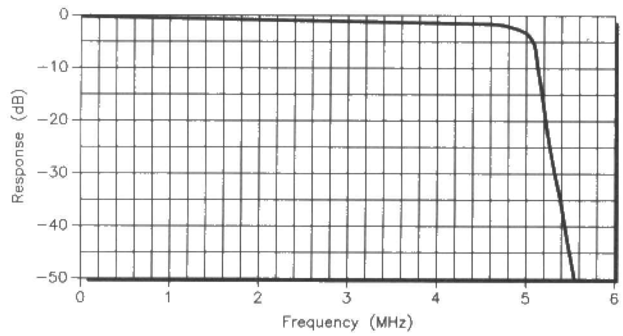


Figure 14b. Frequency response of the 5MHz low-pass filter.

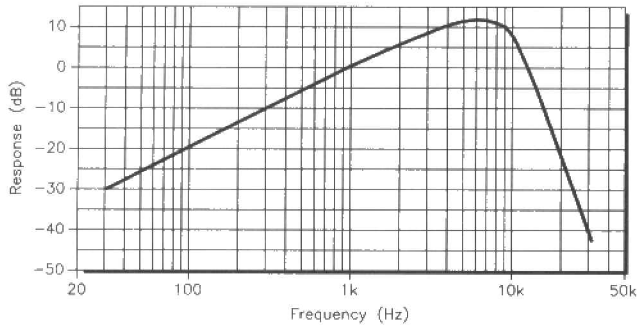


Figure 13. CCIR weighting curve for simulating the disturbing effect of noise in the presence of programme signals.

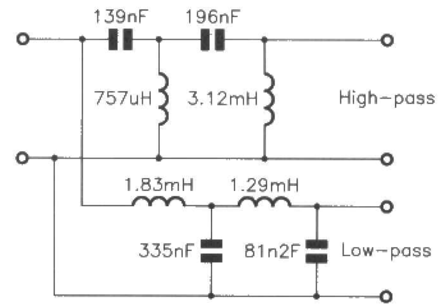


Figure 15a. Complementary 10kHz low- and high-pass filters. Source and load resistances are 75Ω.

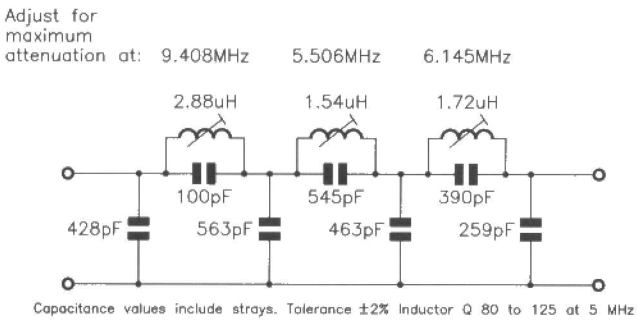


Figure 14a. 5MHz low-pass filter for video noise measurements. Source and load resistances are 75Ω.

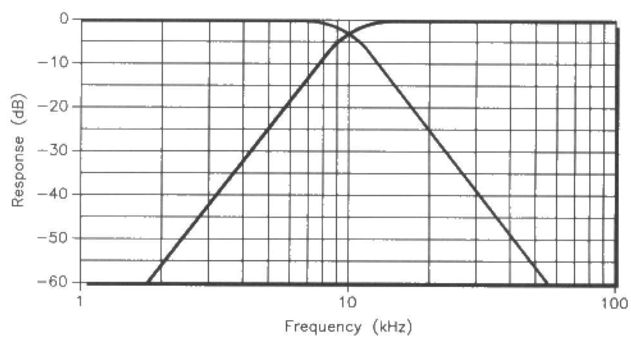


Figure 15b. Responses of the complementary 4th order 10kHz filters.

selected listeners with good hearing) subjectively equal in loudness to 1kHz tones of given sound pressure levels. Sounds of equal loudness are given the same value in *phons* as the sound pressure level in decibels (dB) of the reference 1kHz tone. This early work has been superseded by the Robinson-Dadson curves, see Figure 11.

Long experience has shown that the subjective effects of very quiet to quite loud continuous noises (roughly 20 to 80 phons) can be correlated with objective measurements made with a *weighting filter*, which has a frequency response which is approximately the inverse of the 40 phon equal-loudness contour. It is far from obvious why the 40 phon contour works even for 80 phon noises, but it does. This weighting is called 'A-weighting', because it was the first sort of noise weighting to be standardised. The frequency response curve is rather complicated, because it was derived from the subjective loudness contours, long before modern filter design theory showed the advantages of adopting, where possible, standard forms of filter structure and response. It is defined now in standards (such as BS5969/IEC651), in terms of

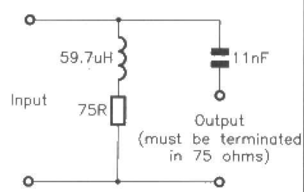


Figure 16a. 200kHz high-pass filter with Zobel network to preserve matching to 75Ω at the input.

the pole positions (see Filters, *Electronics* Issues 82 to 88) of the transfer function, which has two real poles at 20·6Hz, two at 107·7Hz, two at 737·9Hz, and two at 12,200Hz. The resulting frequency response curve is shown in Figure 12. This weighting is intended to be used with a true rms meter, but again, for comparative measurements, an average-responding meter may be used.

Psophometric Weighting

That lovely Greek word just means 'noise-measuring', so it really applies to *any* noise measurement. However, by convention it is only applied to certain measurement methods developed by the former CCITT and CCIR (now ITU/T and ITU/R respectively). The CCITT methods are applied only to telephone systems and we shall not consider them further, but the CCIR method is much more relevant to audio equipment.

Quite a long time ago, the BBC and other broadcasters found that, while A-weighting measurements gave reasonable estimates of the effects of noise *by itself*, they did not at all do this for *noise in the presence of programme*. Many subjective tests and measurements were carried out, and it was found that an even heavier weighting towards high frequencies was necessary, and the true rms meter had to be replaced by a *quasi-peak* responding meter. That 'quasi' is another classical reference, this time to Latin, and it means 'almost'. The need for this meter comes mainly from the subjective effects of clicks and other repetitive impulsive noises, which are particularly disturbing unless the impulse

duration is less than about 5ms. A true peak-reading meter would respond to impulses much shorter than this, so the response is 'slugged' somewhat, in order that very short pulses have less effect on the reading, hence 'quasi-peak'.

The weighting curve was developed, as also was the A-weighting curve, as a result of extensive listening tests, and first appeared in a form which was very difficult to achieve with stable circuits, having a very steep rate of cut-off indeed at the high-frequency end. This was later modified to the form shown in Figure 13, where the main part of the response rises at 12dB/octave and the high-frequency roll-off is at 36dB/octave. It is important to note that the 0dB (unity gain) frequency is 1kHz, and above this frequency, the gain rises above 1. This means that the SNR measured with this weighting and the quasi-peak meter is considerably lower than that measured either unweighted or with A-weighting, unless the noise spectrum is not just unusual but positively weird.

CCIR-ARM

The apparently low values of SNR measured by the CCIR quasi-peak method caused a considerable problem when Dolby Laboratories introduced their B-type noise reduction system. Since the system is specifically intended to reduce the effects of noise in the presence of programme, the CCIR method was clearly the one to choose. Unfortunately, the low values that it produced were seen to be seriously confusing to tape-recorder enthusiasts. Earlier products without noise reduction were normally specified with A-weighting, giving SNRs of the order of 60dB. If products with noise-reduction were specified with CCIR-weighting and the quasi-peak meter, values of the order of 50dB would have to be quoted, even though the real performance was some 6dB *better* than the earlier models.

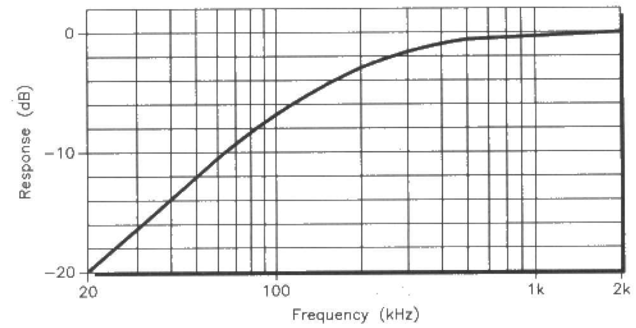


Figure 16b. Theoretical and actual responses of 200kHz high-pass filter using Zobel network matching.

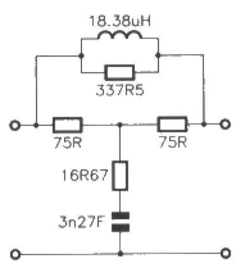


Figure 17a. Noise weighting network for continuous random video noise. Source and load resistances are 75Ω.

Using A-weighting, with less emphasis on the more disturbing high-frequency noise, the effect of switching in the noise reduction system appeared to be only 4dB at most, instead of the real 6dB effect.

This led Dolby Laboratories to propose a new method of measurement, using the CCIR weighting curve displaced downwards on the graph so that the unity-gain frequency became 2kHz, and substituting the quasi-peak meter (which at that time was not easily obtainable anyway) by a cooking-type Average Responding Meter (hence 'ARM'), which every laboratory had. This technique gave better absolute SNR values, comparable with A-weighted values, but retained the improved discrimination which showed the full performance of the noise reduction system. A proposal was made to adopt this method generally as an international standard for all high-fidelity equipment, but it failed on the grounds that there was no scientific justification for changing the unity-gain frequency from 1kHz to 2kHz.

Video Noise Measurements

There are two big snags associated with video noise measurements, and they are called line and field sync pulses! If we took the video camera with the lens cap on which was mentioned earlier, and measured its 'noise' output with the correct 5MHz bandwidth, we would get a result of approximately 300mV, which is the standard sync pulse level. Clearly, we have to do something else. The 'official' solution is to use a special video (luminance) noise meter, which gates out the sync pulses (and the surrounding blanking-level sections in some TV systems), and replaces them with black level. A correction must then to be applied to the noise voltage

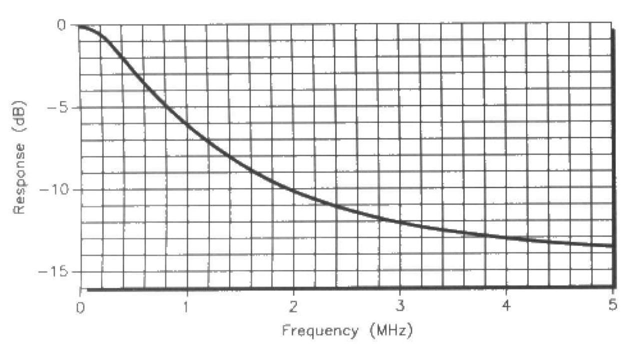


Figure 17b. Frequency response of the video noise weighting network (linear frequency axis).

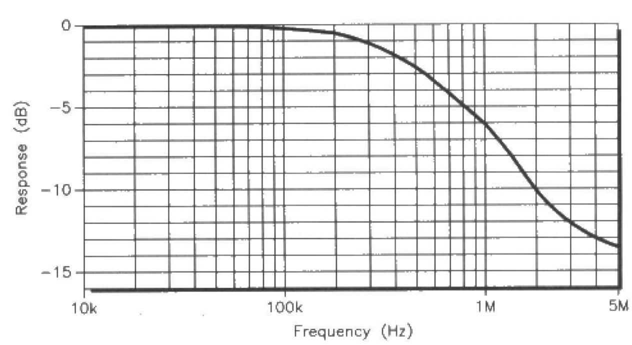


Figure 17c. Frequency response of the video noise weighting network (logarithmic frequency axis).

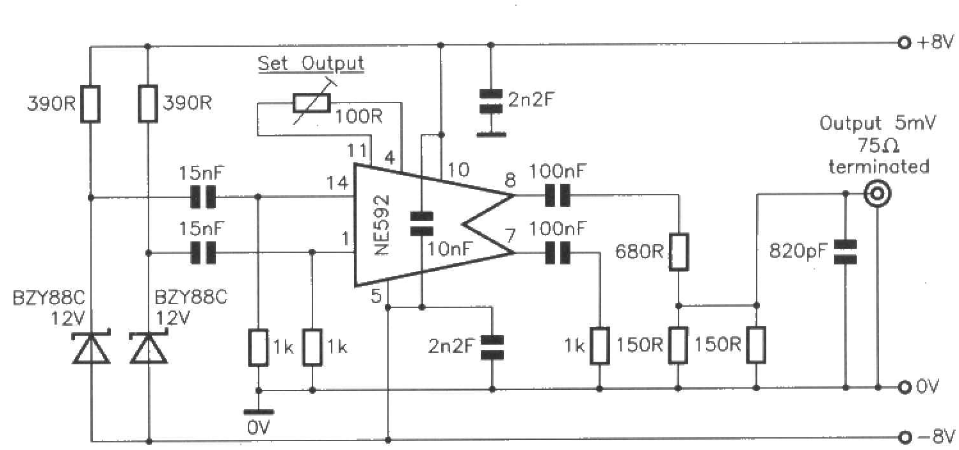


Figure 18. Video noise generator.

to allow for the fraction of time that the signal is artificially set at black level. For 625 line systems, a first correction is based on the line period of 64μs and the line blanking period of 12μs, and is thus a multiplier of 1·231. A further allowance has to be made for the field blanking period of 1,612μs out of the field period of 20ms, leading to a multiplier of 1·088, so the overall correction factor is 1·339. The colour burst must be absent, of course, for this measurement.

Until the Maplin laboratory produces a kit for around £20, a video noise meter is a costly luxury. Luckily, it is possible to use a good oscilloscope to eliminate the effects of the sync pulses. What we do is to display the video (luminance or dark-scene) signal waveform at as near the full height of the screen as possible, while ensuring that there is no crushing of the signal waveform due to non-linearity in the Y-amplifier of the scope. We can then measure the height of the noise signal on the screen, and either use the scope calibrated Y-amplifier sensitivity to convert this height to a voltage, or (better) change the signal input to a noise generator of similar bandwidth (i.e. normally 5MHz), and adjust its output until the display is the same height as for the video noise. We can then use either the noise generator output calibration or a true rms voltmeter of suitable bandwidth to determine its output voltage. With a double-beam scope, one puts the video on, say, Y1 and the noise generator on Y2, and matches the heights by direct comparison, having, of course, checked that the two Y amplifiers have the same gain.

The same principles of band-limiting and weighting are applied to video signals as well as audio signals. There is no IEC or British Standard for luminance noise measurements (shame!), so we have to look at ITU/R (CCIR) Recommendation 567. This lists four different noise measurements: *continuous random noise*, which is to be measured with a true rms meter, a band-limiting filter and a weighting network. The low-pass part of this is specified in Recommendation 567, and is a sixth-order passive elliptical filter with a –3dB frequency of 5MHz, and over 50dB attenuation at 6MHz (see Figures 14a and 14b). The high-pass part is part of a combined 10kHz high- and low-pass filter, which is composed of fourth-order passive LC filters, and looks like a loudspeaker crossover network on the circuit diagram (shown by Figures 15a and 15b). The high-pass output is used for noise measurements and the low-pass output for mains hum and its harmonics. For measurements in the presence of a signal, a 200kHz first-order, high-pass filter is necessary. To preserve correct matching to 75Ω, the basic CR high-pass filter has to have a LR Zobel network added at its input, as shown in Figures 16a and 16b. However, for measurements of video tape noise, the high-pass filter cut-off frequency has to be 100kHz (IEC735/BS EN60735), which requires twice the capacitance and twice the inductance.

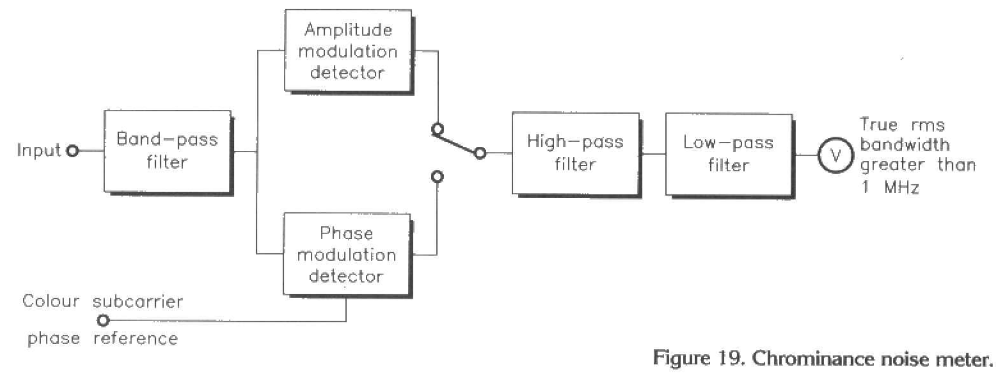


Figure 19. Chrominance noise meter.

The second type of noise is *low frequency noise*, for which a wide band-pass filter is recommended. The low-pass part can be the 5MHz filter shown in Figure 14. However, the Recommendation says that the high-pass filter 'requires further study', which is not very helpful. It is even less helpful in the case of *periodic noise*, where no specific method of measurement is given at all. For *impulsive noise*, it is simply recommended to use an oscilloscope.

The weighting network for continuous random noise is a form of bridged-T (refer to Figures 17a to 17c). The weighting is intended to make the noise voltage and SNR measurements correlate with the subjective effects of video noise on the picture display. It is possible to make up these filters and the weighting network mostly from Maplin parts, preferably in small die-cast boxes in view of the high frequencies involved. Of course, there is not much point in making the filters without a video noise source to go with them. This also is not too difficult to build, although it must be remembered that frequencies up to 5MHz are involved, so short leads and careful layout are required. The noise is generated as the difference between the noise voltages across two current-fed avalanche diodes ('Zener' diodes with forward voltages in excess of 6·2V). This difference voltage has a more accurately Gaussian probability density distribution than the original noise voltages, and is produced by coupling the original noise voltages to the differential inputs of a NE592 (or LM592) video amplifier device,

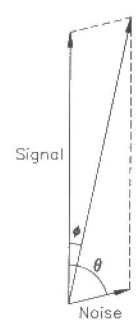


Figure 20. Phasor diagram showing how a noise signal can produce phase modulation.

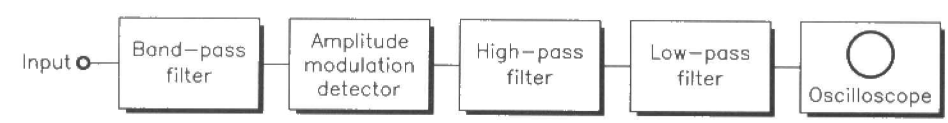


Figure 21. Chrominance noise measurement with an oscilloscope.

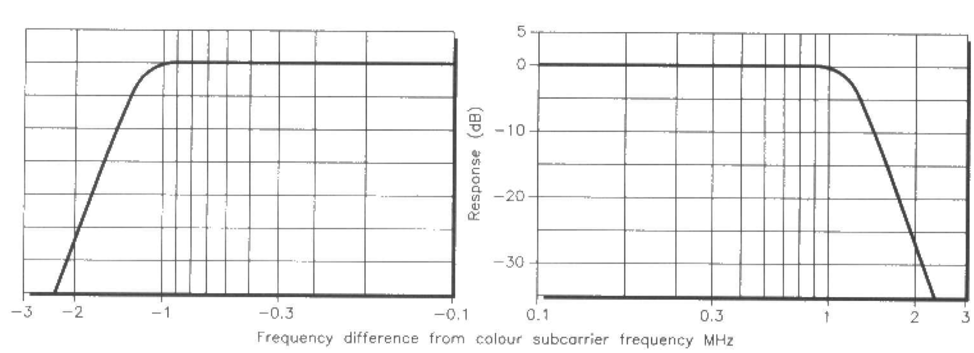


Figure 22. Frequency response of the chrominance noise band-pass filter.

as shown in Figure 18. The CR coupling gives a roll-off below 10kHz, and the high-frequency band limit is set to 5MHz by the filter shown in Figure 14, which is connected to the 75Ω output. The output level can be set by means of the 100Ω preset potentiometer connected between pins 4 and 11 of the IC. The supply voltages MUST NOT exceed ±8V. To verify that the generator is producing noise of the right bandwidth with a flat spectrum, a spectrum analyser is almost essential, although there are other possibilities. Still, if it is carefully constructed, the generator should be quite accurate.

Chrominance Noise Measurement

There is an international standard, IEC883 (BS7595), for the measurement of chrominance noise on video tape recorders, and there is no chrominance noise measurement mentioned in ITU/R Recommendation 567. The principle is shown in Figure 19, and is complicated by the need to take *phase noise* into account, as well as the amplitude noise we have been considering so far. This is because, in the PAL and NTSC colour systems, the reproduced colour depends on the amplitude of the chrominance signal for its saturation (intensity) and the phase for its hue (colour). For SECAM, the subject is more complex, but the phase does matter.

Phase noise arises from the effect shown in the phasor diagram of Figure 20, where a small noise signal is added to a wanted signal at some phase angle, θ. This shifts the phase of the combined signal by a much smaller angle ϕ, which depends on both the amplitude and phase of the noise signal. Thus, amplitude noise automatically generates phase noise. However, the amount of phase noise produced depends on the spectrum of the amplitude noise, so it is not easy to predict, and therefore has to be measured separately.

For many purposes, a measurement of amplitude noise is sufficient, and this can be done with an oscilloscope, as shown in Figure 21. The filters indicated in Figure 19 are still required. A 10kHz first order high-pass filter is used for tape noise measurements, and a 100kHz filter for overall measurements. Note that this is the reverse of the procedure for luminance measurements. The low-pass filter, however, has a much steeper cut-off. For both tape and overall noise, the –3dB frequency is 1MHz, except for 'colour under' systems (such as VHS), for which 500kHz is to be used. The filters are specified in such a way that it appears that Butterworth filters are intended to be used, and this means that the 1MHz filter has to be of the 7th order, while the 500kHz filter has to be of the 6th order. These can be made most conveniently as passive LC filters.

The band-pass filter target specification, related to the 4·43MHz colour subcarrier frequency used for 625/50 television systems, is shown in Figure 22. This requires a 6th-order Butterworth filter, but 0·5dB ripple is in fact allowed in the pass-band, so a 4th-order Chebyshev filter might be practicable, if the component values do not prove inconvenient.

Measurements of Noise with Different Meters and Weightings

To show the importance of knowing the type of meter to be used and the measuring bandwidth, Table 1 shows actual measurements of the output in mV of a Brüel & Kjær 1405 noise generator with a variety of meters and weightings. The LA102 is a Lindos digital meter, mainly intended for computer-assisted audio measurements. 'PPM' means the standard BBC-type Peak Programme Meter (BS6840-10), whilst 'vu' means the standard volume indicator (BS6840-17). The V250 is an early design of transistor analogue millivoltmeter, whose bandwidth has been restricted to 650kHz for stability reasons. It has insufficient voltage-swing capability (headroom) in the meter driver to handle noise signals near full-scale deflection without serious clipping. The Brüel & Kjær 2608, on the other hand, uses valves (tubes) and has a bandwidth of 200kHz with very high headroom. The Maplin M4510 is a low-cost portable digital multimeter (now discontinued, but similar to the M205, ZC55K), while the Fluke 8000A is a bench-type digital multimeter, and the Skywood PL-436 is an elderly analogue multimeter. The digital meters and the 2608 have true-rms rectification, while the others have average rectification, are scaled to read rms values on sine-wave signals, and thus, are expected to read about 10% low on white noise signals. The higher proportion of low-frequency energy in pink noise signals makes the readings jitter more than for white noise, so the results are less precise.

Meter type	Rectifier bandwidth (Hz)	White noise 100kHz bandwidth (mV)	White noise 20kHz bandwidth (mV)	Pink noise 50kHz bandwidth (mV)
LA102	rms 2 to 100k	1,000 (setup)	1,000 (setup)	1,000 (setup)
	rms 22·4 to 22·4k	550	945	944
	PPM 22·4 to 22·4k	820	1,450	1,290
	vu 22·4 to 22·4k	470	840	616
	rms A-weighted	430	745	620
	rms 2 to 100k slow	1,000	1,000	1,000
	CCIR weighted, quasi-peak	1,780	3,240	2,250
	CCIR unweighted, QP	827	1,440	1,300
	CCIR-ARM, 0dB at 1kHz	1,050	1,700	1,290
	CCIR unweighted, rms	1,200	1,810	1,480
	CCIR-ARM, 0dB at 2kHz	545	900	685
V250	ARM, 10 to 650k	920	825	865
2608	2 to 200k	1,160	999	998
	A-weighted	403	705	612
M4510	ARM, BW unspecified	866	840	840
8000A	rms, BW unknown	992	899	865
pL-436	ARM, BW unspecified	520	750	632

Table 1.

Glossary of Terms

ITU International Telecommunications Union
CCIR Comite Consultatif International des Radiocommunications (International Radio Consultative Committee)
CCITT Comite Consultatif International Telegrafique et Telephonique (International Telegraph and Telephone Consultative Committee)
PAL Phase Alternating Line
NTSC National Television Systems Committee
SECAM Systéme En Couleurs á Mémoire

Exhaust(ed) Noise

This concludes the series on noise theory and measurement. As usual, there is much more in the subject that could be covered, but fairly small doses are usually more palatable.

COMPACT TELEVISION TUNER

FOR USE WITH THE IBM-PC TELETEXT DECODER FOR WINDOWS

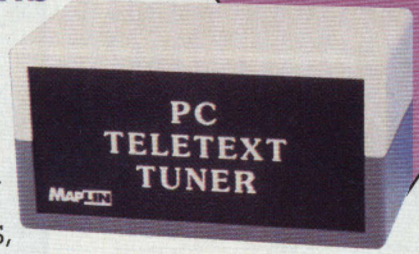
KIT AVAILABLE (90037) Price £29.99

Please note that a colour TV licence will be required for legal use of this project.

PART 2

APPLICATIONS

* Complements the PC Teletext Decoder Interface Card (90035)
* Experimental TV tuner for hobbyists, schools and colleges



Design by Tony Williams
Technical support by Dennis Butcher
Text by Tony Williams and Maurice Hunt

2 PROJECT RATING

FEATURES

* Voltage-controlled tuning
* Onboard DC-to-DC converter
* Built-in, switchable automatic frequency control (AFC)
* Single +12V power requirement
* Excellent reception of TV video information signal
* Designed to match the PC Teletext Decoder Interface Card (90035)
* Compact, efficient, low power design
* Portable, allowing use with laptop and desk PCs

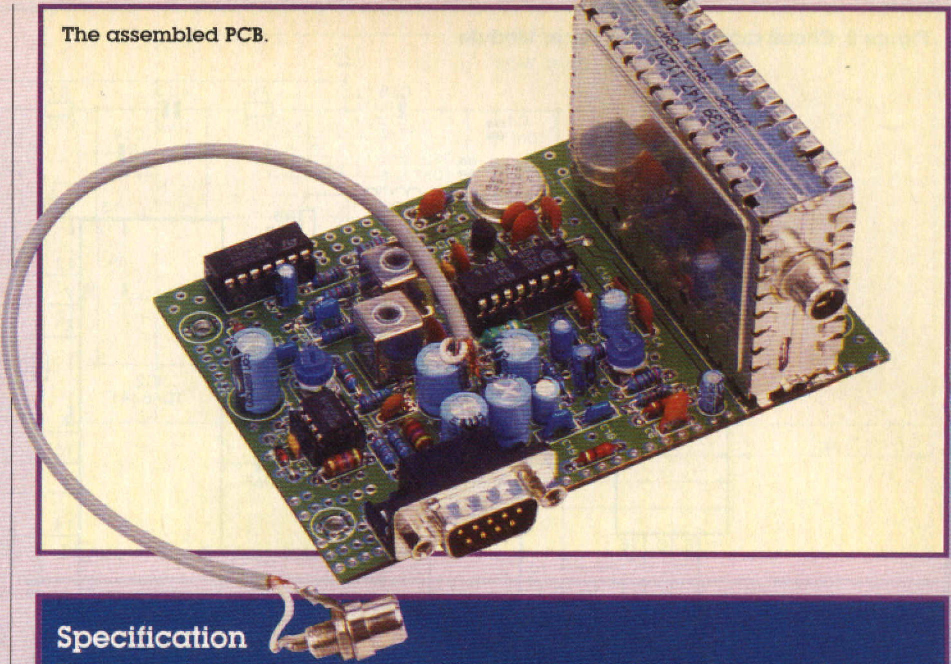
This compact Television Tuner Module has been designed to perfectly complement the PC Teletext Decoder Interface Card, also described in this issue of *Electronics*, but it is also suited to other applications and projects that demand a convenient source of television video signals, without the need to lug a bulky TV set or video recorder around with you!

NATURALLY, a teletext decoder system, such as the one described here, needs its own source of video information in order to operate correctly. If your computer is situated near to a video recorder, then your PC Teletext Decoder could use this as a supply of composite video. However, this has two disadvantages – you will not be able to control the video from your PC (at least, not without some major modifications beforehand!), meaning that you will actually have to get up and walk over to it in order to change channels, and secondly, not many people have such a comfortable arrangement! For those of you who would like to build a dedicated television tuner, the unit presented here is compact, portable and gives excellent results – it may (depending on where you use the system) even receive European television broadcasts, which could be useful if you are learning a foreign

language. However, as it is intended for use with a teletext system, the tuner does not generate any audio output.

This versatile TV tuner module can be tuned to any frequency in the 400 to 800MHz television band (channels E22 to E62), by applying a 0 to 10V DC tuning voltage to pin 1 of the board's 9-pin D-type connector. An automatic frequency control (AFC) lock/unlock facility improves the unit's immunity to drifting and other external sources of noise, and automatic gain control (AGC) is also incorporated into the design. Both the tuning and the AFC can be controlled from the computer via the Teletext Decoder software's tuning panel. Used in conjunction with a portable aerial (such as a telescopic or loop antenna), the whole system could be used from a laptop PC, and give you access to teletext from just about anywhere!

The assembled PCB.



Specification

Power supply:	Uses internal PC 12V DC regulated supply
Current consumption:	≈100mA
RF (UHF)	
Tuning range:	Channels E22 to E62
400 to 800MHz (UHF TV video)	
Aerial input:	75Ω Phono
Noise figure:	10dB maximum
Voltage gain:	40dB
AGC range:	30dB
AFC range:	±120kHz
IF	
Vision carrier:	39·50MHz
Colour carrier:	35·07MHz
Video (Composite)	
Output level:	1V Pk-to-Pk
Output load :	75Ω
Bandwidth :	7·5MHz
Signal to noise ratio:	S/(S+N) 58dB
PCB	
Type:	Double-sided, plated-through holes, gold-plated edge connector
Dimensions:	109×77mm
Component height:	50mm maximum

Circuit Description

The block diagram of this module is detailed in Figure 1, whilst Figure 2 provides the circuit diagram. Reference to these should assist you when following the circuit description or fault-finding in the completed unit. The UHF front-end is a manufactured module, which requires no alignment and uses the latest surface mount components. Its output drives a Surface Acoustic Wave (SAW) filter, which produces the IF for vision processing. The tuner unit has automatic frequency control (AFC), and automatic gain control (AGC) circuitry.

The DC power for the circuit is supplied from the PC's 12V DC regulated supply, via pins 4 and 9 of the D-type connector, PL1. The input voltage is low-frequency decoupled by capacitor C15, and further high- and low-frequency decoupling is provided at regular intervals throughout the rest of the circuit.

The UHF front-end, comprising UHF modulator TU1, is varicap tuned using three BB405 capacitance diodes, and a reference voltage of at least +28V is required to obtain the full tuning range of 400 to 800MHz (channels E22 to E62). To select the desired TV channel/frequency, the PC is used to generate a tuning voltage of between 0 and 10V which is fed into the board via pin 1 of the D-type connector. The onboard DC-to-DC converter, IC2, is used to triple this up to the 0 to 30V range needed by the tuning module itself.

TU1 has a number of terminals for power, tune voltage, AGC and IF output, with the TV aerial connecting to a phono socket mounted on one side of the module. The IF output contains the vision, and colour, plus Teletext signals (contained within the vision information). These signals are split by the SAW filter, SAW1, which generates two IF outputs, one

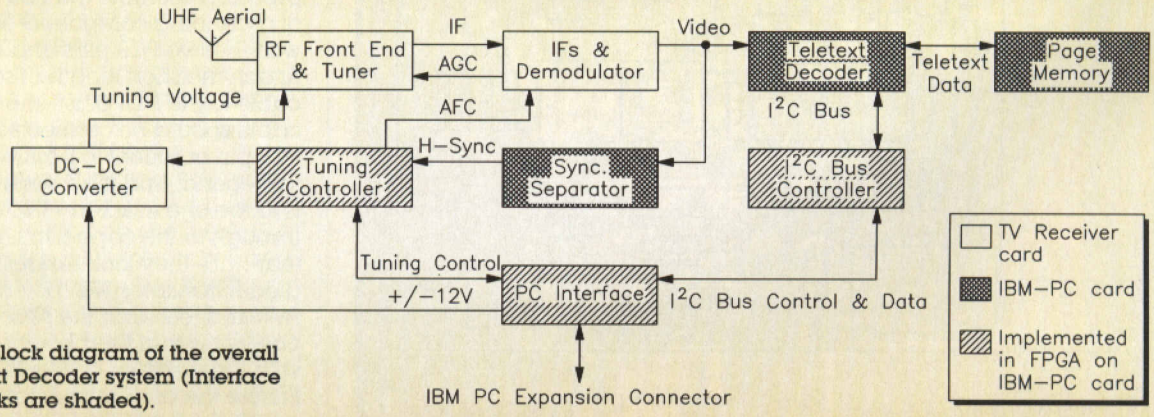
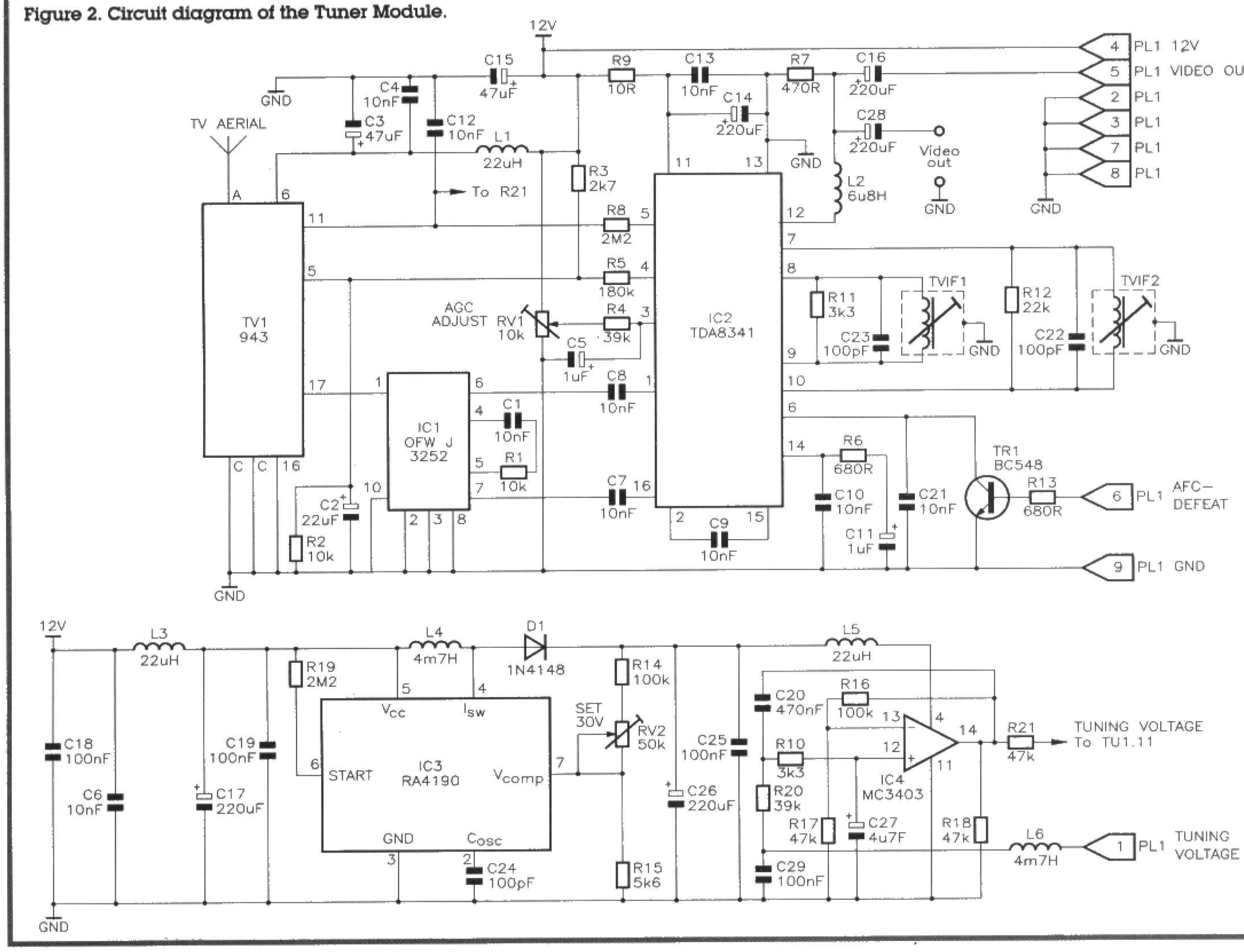


Figure 1. Block diagram of the overall PC Teletext Decoder system (Interface Card blocks are shaded).

Figure 2. Circuit diagram of the Tuner Module.



containing vision and colour information, leaving the sound IF on the other, but because this is not needed, components R1 and C1 are added to provide a 'dummy' load for the unused sound output.

The vision IF is passed into IC1, a TDA8341 TV IF amplifier and demodulator IC, which produces a composite video output on pin 12. This is then fed via L2 and C16 to pin 5 of PL1. In addition, this chip produces the AFC and AGC control voltages, which are fed back to TU1. Video demodulation is controlled by a tuned circuit comprising of T1, C23 and R11. A similar tuned circuit, formed by T2, C22 and R12, is used to set the AFC tuning voltage on pin 5, which is connected back to the tuning voltage input of TU1 via R8. The AFC action can be switched out by connecting pin 6 to the 0V ground, and this is achieved by means of TR1, controlled via pin 6 of PL1; a logic 1 applied here turns off the AFC. The AGC output on pin 4 is controlled by the AGC starting point preset RV1 on pin 3.

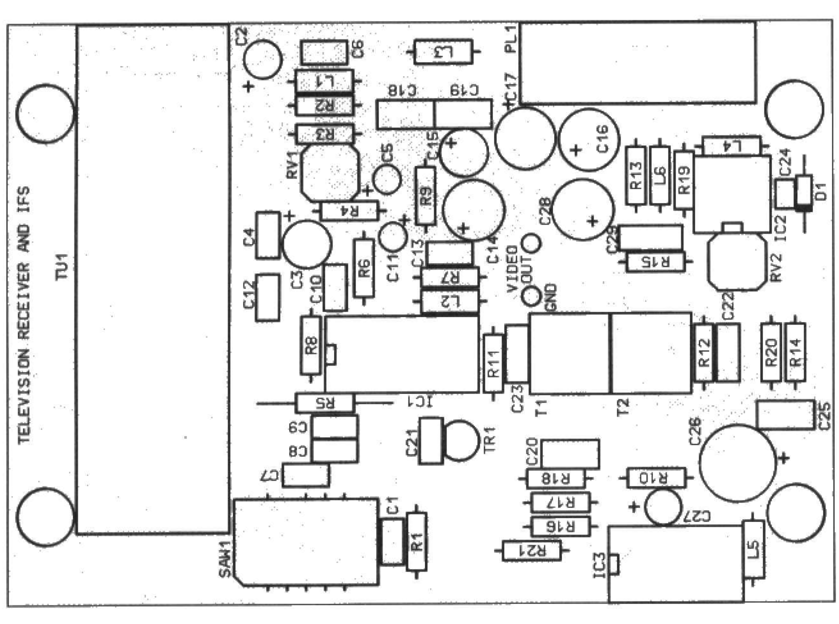


Figure 3. PCB legend.

PCB Construction

Construction of the tuner module is not difficult, but reasonable care and attention is necessary, as the circuit board is double-sided, and removal of a component may be difficult at a later stage. Refer to Figure 2, showing the circuit diagram, and Figure 3, of the PCB legend and track, which will be of assistance with the building-up process. Assemble the PCB in order of ascending component size, starting with the two PCB pins and resistors. Attach the short length of screened cable to the PCB pins – the inner cable should be connected to the PCB pin adjacent to positive (+) on the legend, and the screen connection is to the one marked 'GND'. Progress through to the capacitors, inductors (careful – they look like resistors!), diode, transistor TR1, potentiometers RV1 and RV2, and the IC sockets, observing that their notches align with those shown on the PCB legend. Ensure the correct orientation of polarity-conscious components.

Mount the SAW filter, SAW1, at this stage, but note that it should not be socket-mounted. Also, as it is quite sensitive to overheating, solder one leg at a time, giving it time to cool down again in between. Next, fit the TV video IF coils, T1 and T2. Then fit the 9-way D-type socket, soldering its end 'chassis' terminals to the PCB as well as all its pins. Mount the UHF modulator, TU1, bending the mounting tabs (outwards) and soldering them to the PCB pads for added rigidity and to provide a good earth connection to the ground plane. The final assembly stage is to carefully install IC1 to IC3 into the appropriate sockets, observing anti-static precautions, and ensuring they are fitted the correct way round. If a connection is required for an external video monitor, fit the phono socket to the free end of the screened cable if you intend to fit these (see Optional parts list).

Box Preparation

Refer to Figure 4, which gives details of the drilling required for the casing. Figure 5 depicts the front and rear panel labels, while Figure 6 shows the exploded assembly diagram of the completed unit. Use the markings printed on the (rear) panel label to guide you when drilling the holes for the sockets, by marking the drilling position with a centre punch, large nail, or similar. File out the holes as necessary, to accept the sockets. The rectangular hole for the D-type socket will require a series of holes to be drilled within the area defined on the label, and then, having created a hole that is nearly large enough, use a small file to enlarge it to the right dimensions and shape. Note, only drill the hole for the optional phono Video Out socket, if required. Clean the aluminium panels of all swarf and/or grease prior to applying the labels. Fit the front panel into its guide slots in the box base, and fit the PCB's sockets into their respective holes in the drilled rear panel, prior to sliding this sub-assembly into the box base. Use the four small self-tapping screws supplied with the box to secure the PCB in place within the base.

Testing and Alignment

Having examined the board carefully, and satisfied yourself that you have not made any obvious mistakes, make some rudimentary tests. For testing, you will need the following items: a 12V 300mA regulated power supply, a voltmeter, a 10kΩ potentiometer (for the tuning control), an SPST switch (for the AFC switching), a 9-pin D-type socket, and a composite video monitor. If you do not have access to the latter, then you might like to use a normal television and video recorder combination. Most videos have an auxiliary video input, with which you can monitor a

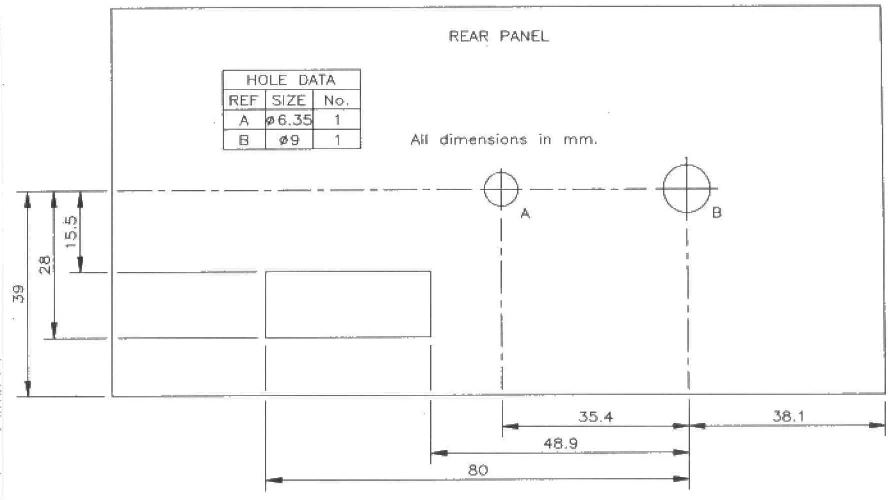


Figure 4. Box drilling details.

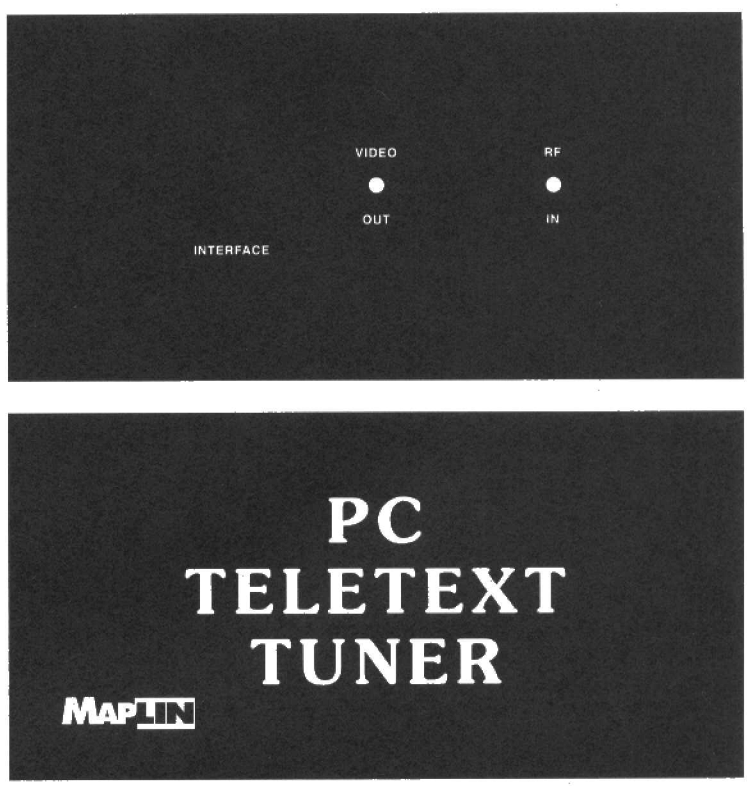
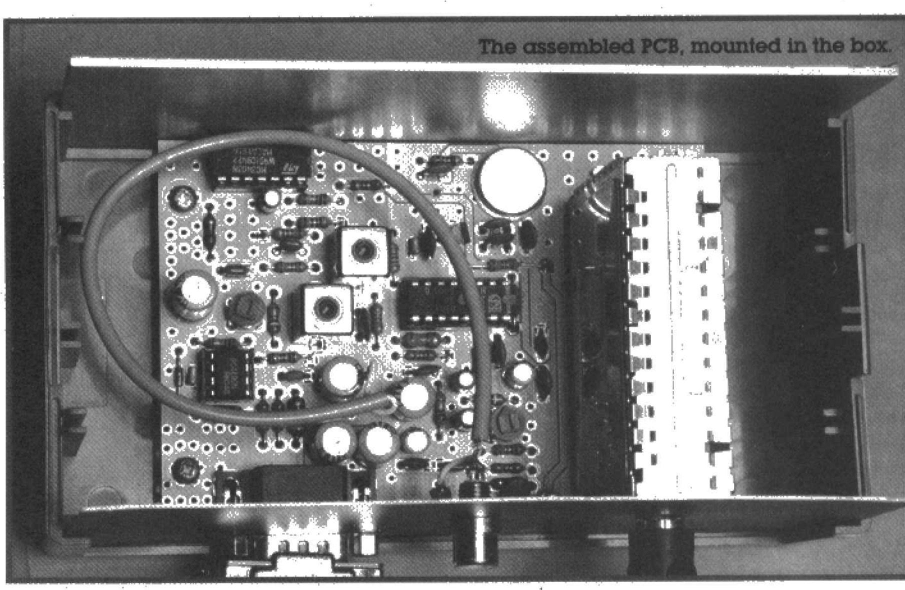


Figure 5. Front and rear panel labels (scale 66%).



The assembled PCB, mounted in the box.

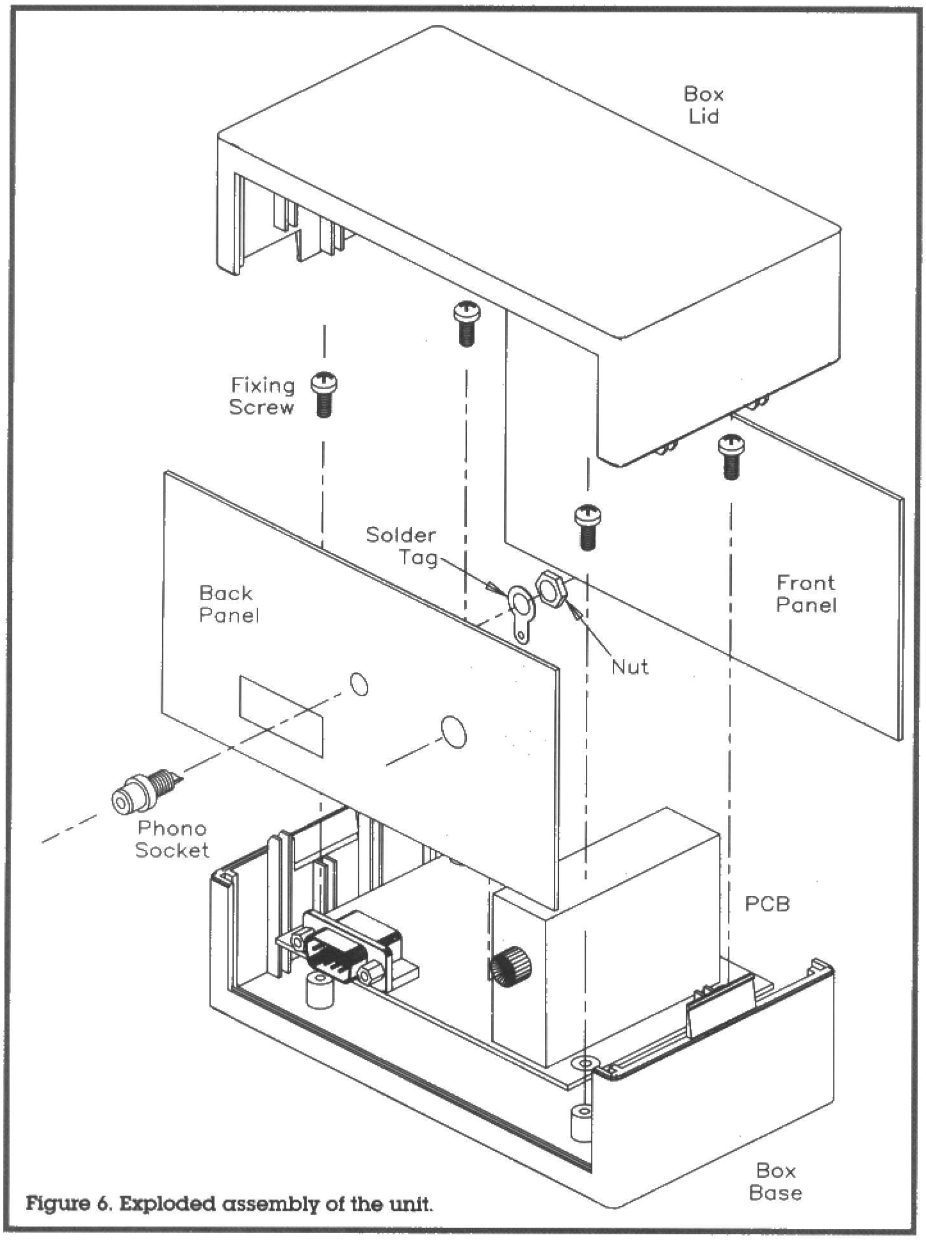


Figure 6. Exploded assembly of the unit.

should see a fairly typical 'snow' pattern, indicating that the tuner is not tuned in. If the screen stays blank, turn the power off and check that all your connections are sound, and that the monitor (or video) is actually set to display the tuner's output. You might also check in the vicinity of R9, L2 and C16, and confirm that IC1 has been inserted correctly.

To tune the tuner, rotate the tuning potentiometer which will enable you to receive several stations with excellent clarity. Because of the tuning potentiometer's relatively short travel, it may be difficult to tune the tuner with any degree of accuracy, but persevere, and try to get the best reception. If the picture remains snowy or you cannot find a stable picture, check that RV2 is rotated fully clockwise, and that you have not accidentally used the wrong value resistors for R2 to R5. If the image appears to be shaky or has diagonal lines across it, this could be due to noise from your power supply. Try a better supply (or even a battery) and/or try grounding the metal case of the tuning potentiometer. Alternatively, if you live near to a television transmitter, degradation could be caused by excessive signal strength at the aerial – although for most of us, this is unlikely. This can be compensated for by slowly rotating RV1 anticlockwise. Turn it until the picture quality reaches its peak, and leave it there. Using a trimming tool (BR51F), carefully adjust the iron dust cores of T1 and T2, unscrewing them (turn anticlockwise), until they are flush with the top of their screening cans. Next, adjust each coil in a clockwise direction as follows:

T1 = 4·5 turns
T2 = 3·5 turns

Next, the tuner module will need to be calibrated, as follows. With the AFC turned off (by applying a logic 1 to pin 6 of PL1 or by using the test switch as per the wiring diagram), adjust the tuning voltage potentiomenter to a

composite video signal from another source, such as a camcorder. In addition, you will also need access to a known-to-be-good TV aerial. Note that the aerial socket on the tuner module is a phono type, and will not accept a normal TV aerial connector. Some form of adaptor, or temporarily replacing the TV aerial connector with a phono plug, will be required. Make a test lead, and connect the above-mentioned test components, as per Figure 7.

Testing will require the following set up:

Insert IC2 and IC3, and apply the 12V supply, +12V to pin 4, and 0V to pin 9 of PL1. The board should draw around 100mA, and you should see approximately 30V across the terminals of C26. Set this to around 31V, by adjusting RV2 (if you do not have a multimeter, set RV2 to its mid-position). If you see only 12V across C26, then check that IC2 and D1 have been inserted the correct way round. Fully rotating the 'tuning' potentiometer should cause the voltage on pin 14 of IC3 to change from around 0·5 to 30·5V.

Turn the power off, and insert IC1. With the power on, the board should now draw 100 to 150mA, and IC1 may become warm to the touch. Ensuring that the AFC switch is open-circuit and RV1 is rotated fully clockwise, attach the aerial and connect the board's composite video output to your monitor. On the screen, you

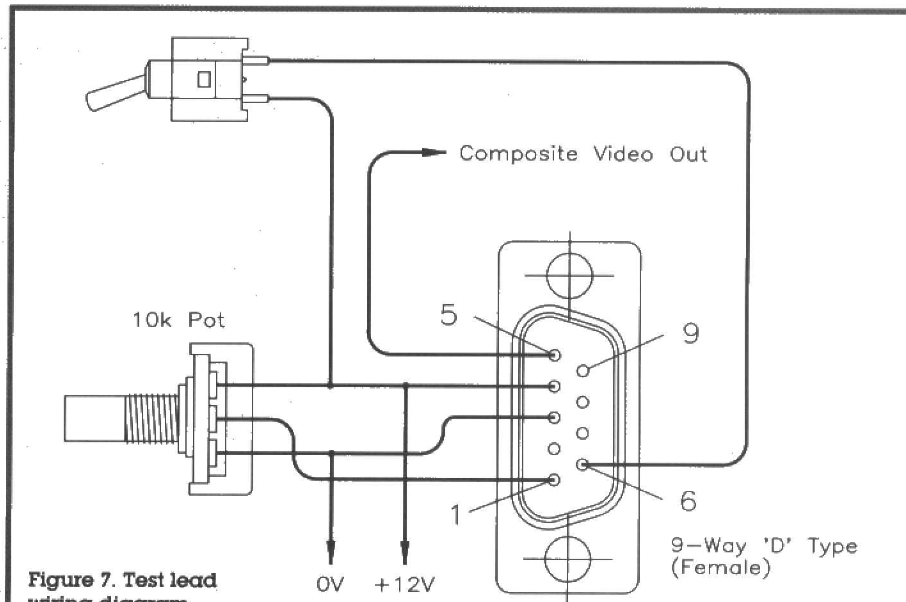


Figure 7. Test lead wiring diagram.

local TV channel, so that as clear a picture as possible is obtained on the composite video monitor. If the picture quality is poor, adjust T1 until no further improvement can be observed. Switch on the AFC, and adjust T2 so that the picture is the same with the AFC on or off.

Testing the AFC involves tuning to a station and then backing off a little. With the picture slightly fuzzy, open and close the AFC switch a few times. The picture should improve with the AFC switch closed, and return to its fuzzy state with the AFC switch open.

Assuming that everything appears to be operating correctly, it is time to remove the test components and attach the tuner to the main card in the PC (actually, you might like to keep the connection to the monitor, as this will allow you to confirm that the software's signal strength meter is working correctly). Figure 8 shows how to build the connecting cable, the terminating pins of which are allocated as below. Good quality 4-core screened cable is ideal for the job of linking the two boards, and a cable length of not more than 1·5m is suggested. Longer cable runs will degrade the quality of the video signal and act as an aerial for any electromagnetic noise in the area.

Pin 1:	Tuning voltage
Pin 4:	+12V DC
Pin 5:	Composite video output
Pin 6:	AFC on/off
Note:	Pins 1,2,7,8,9 are all connected to GND

Without attaching the tuner unit itself, plug one end of the cable into the socket on the PC-card, power up the PC and start the teletext decoder software. Pressing the 'Tuner' button on the teletext window should reveal the tuning panel, and pressing the left and right arrows at either ends of the tuning bar should move the indicator accordingly. (Note that clicking on the double arrows on either end of the tuning scale moves the tuning indicator by a medium amount, the single arrows a small amount, and clicking on the grey area to either side of the tuning indicator moves it by a large amount.) Use a voltmeter to check that the voltage on pin 1 of the 9-way D-type connector varies as you move the tuning indicator left and right. You might also check that pin 6 switches between 0 and 5V as you switch the AFC control on and off.

Next, plug the connector into the tuner module, and observe the composite video output on the monitor (be very watchful at this point! If your computer misbehaves in any way, then turn it off immediately and check that the tuner module's +12V supply is not shorting to GND). You should find that you can now tune the tuner by moving the indicator on the tuning panel. As you move the tuning indicator across its entire range, look for peaks on the signal strength meter. At these points, a picture should become visible on the monitor. The signal strength meter should get you very close to a good signal, but you will probably have to do a little fine-tuning before the teletext decoder has a clear enough signal to work with. Once you have a clear picture on the monitor, you should see the clock in the top right-hand corner of the main window begin to update. This indicates that you are now receiving good teletext data. In general, it is a good idea to turn off the AFC whilst tuning the tuner, and switch it on again once you have located a good station.

Once you have found a clear picture, you can save its location to a preset button. To do this, double-click on the signal strength meter and select one of the nine presets.

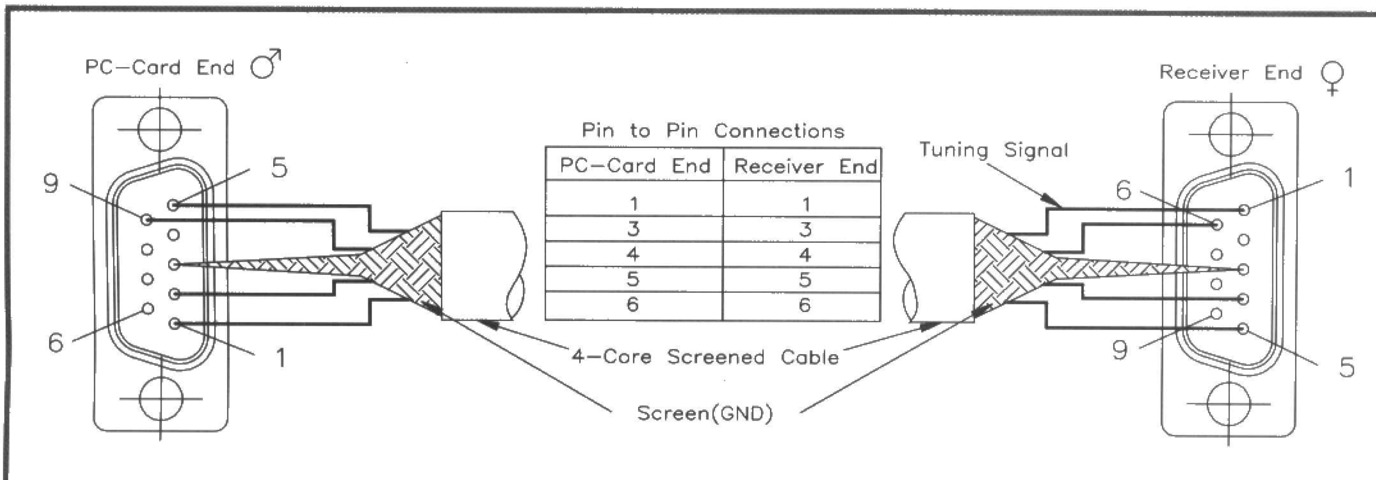
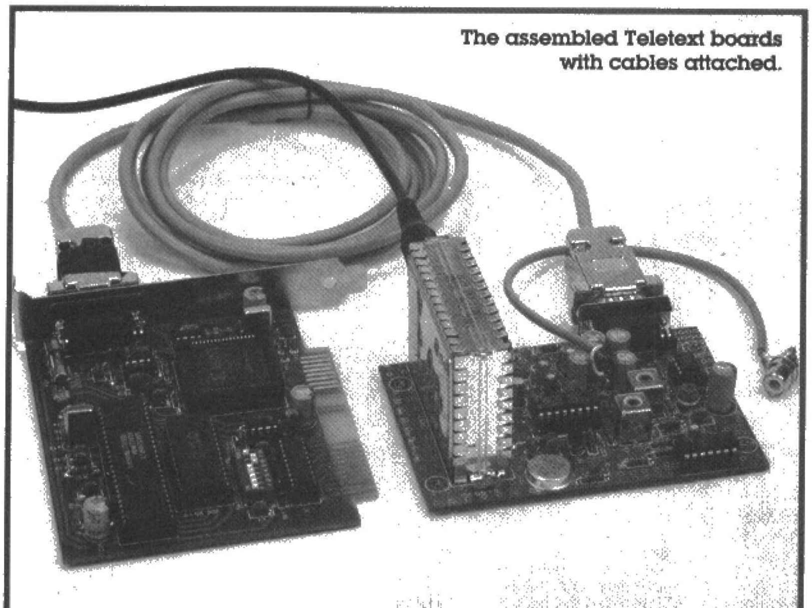
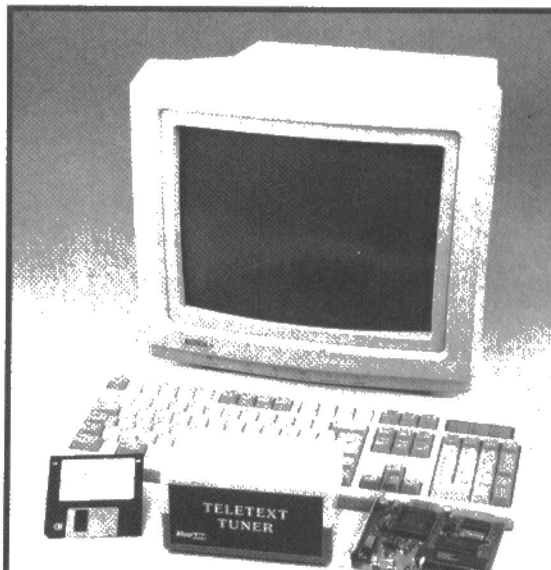


Figure 8. Wiring diagram, showing interconnection cable between the Tuner Module and the Interface Card.



The assembled Teletext boards with cables attached.



The complete system.

Subsequent pressing of this preset button will return you to precisely this point on the scale. Note that the 'Scan' button on the tuning window is used to automatically scan across the entire tuning range and record the signal strength as it goes. Pressing the 'Scan' button sends the tuning indicator all the way to one extreme, and moves it slowly across to the other. As the bar moves, a graph is drawn in the blacked-out region above. The peaks on the graph correspond with the strongest signals. Initially, this can be used as a rough guide to help you find some stations.

Having found a station, the clock will begin to update (you may have to fine-tune the tuner until it does so reliably) and you can close the tuning window. Select teletext page 100, and within a few seconds, it should appear on the main window! You are now ready to browse through the myriad of pages on offer, at your leisure.

Note: With everything in place, and the unit operating satisfactorily, slide the tuner module's box lid on, and press down, which will click the box shut. Finally, turn the box over, and apply the stick-on feet (supplied), one at each corner of the box base. The specified box design has concealed catches that hold the two halves together (as opposed to screws); if, for any reason, you need to undo the box lid, the technique for removal is to push the blade of a thin, flat-headed screwdriver into the centre point of each box end in turn, using moderate pushing force. Gently twist the screwdriver (taking care not to gouge the edges of the box), whereupon the box halves should separate enough to enable you to pull them apart. E

PC TELETEXT DECODER – TUNER MODULE PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)

R1,2	10k	2	(M10K)
R3	2k7	1	(M2K7)
R4,20	39k	2	(M39K)
R5	180Ω	1	(M180R)
R6,13	680Ω	2	(M680R)
R7	470Ω	1	(M470R)
R8,19	2M2	2	(M2M2)
R9	10Ω	1	(M10R)
R10,11	3k3	2	(M3K3)
R12	22k	1	(M22K)
R14,16	100k	2	(M100K)
R15	5k6	1	(M5K6)
R17,18,21	47k	3	(M47K)
RV1	10k Horizontal Cermet Preset Potentiometer	1	(WR42V)
RV2	50k Horizontal Cermet Preset Potentiometer	1	(WR43W)

CAPACITORS

C1,4,6-10, 12,13,21	10nF Metallised Ceramic Disc	10	(WX77J)
C2	22µF 16V General Electrolytic	1	(AT99H)
C3,15	47µF 16V General Electrolytic	2	(AU01B)
C5,11	1µF 63V General Electrolytic	2	(AU09K)
C14,16,17	220µF 16V General Electrolytic	3	(AT41U)
C18,19,25	100nF Monolithic Ceramic	3	(RA49D)
C20	470nF Monolithic Ceramic	1	(RA52G)
C22, 23	100pF Metallised Ceramic Disc	2	(WX56L)
C24	100pF Metallised Ceramic Disc	1	(RA36P)
C26	220µF 35V Radial Electrolytic	1	(AT60Q)
C27	4µ7F 35V General Electrolytic	1	(AU05F)
C29	100nF 16V Disc Ceramic	1	(YR75S)

SEMICONDUCTORS

D1	1N4148	1	(QL80B)
TR1	BC548	1	(QB73Q)
SAW1	SAW TV IF Filter	1	(GV15R)
IC1	TDA8341-N6	1	(UL27E)
IC2	RC4190N	1	(UR15R)
IC3	MC3403N	1	(QH51F)

MISCELLANEOUS

L1,3,5	22µH RF Choke	3	(WH37S)
L2	6µ8H RF Choke	1	(WH34M)
L4,6	4m7H Choke	2	(UK80B)
T1,2	TV Video IF Coil	2	(UL55K)
TU1	UHF TV Tunerhead Module Type 943	1	(JR59P)
PL1	9-way Right-angled D-type Plug	1	(FG66W)
	8-pin DIL Socket	1	(BL17T)
	14-pin DIL Socket	1	(BL18U)
	16-pin DIL Socket	1	(BL19V)
	Front and Rear Panel Labels	1	(90039)
	PCB	1	(90038)
	Instruction Leaflet	1	(XV59P)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

C28	220µF 16V Radial Electrolytic	1	(FF13P)
	Verobox Type 213	1	(LL10L)
	Single-ended PCB Pin 1mm (0·04in.)	1 Pkt	(FL24B)
	Chassis-mounted Phono Socket	1	(YW06G)
	Single-core Lapped Screen Cable White	1m	(XR14Q)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit which offers a saving over buying the parts separately.

Order As 90037 (PC Teletext Decoder – Tuner Module) Price £29.99

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue.

PC Teletext – Tuner Module PCB **Order As 90038 Price £8.99**

PC Teletext – Tuner Module Front Panel Label **Order As 90039 Price £2.49**

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AARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Cresent, Kincorth. For further details contact Martin GM0JCN Tel: (01569) 731177.

WIRRAL AMATEUR RADIO SOCIETY meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the 1st and 3rd Wednesday of every month. Details: A. Seed (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

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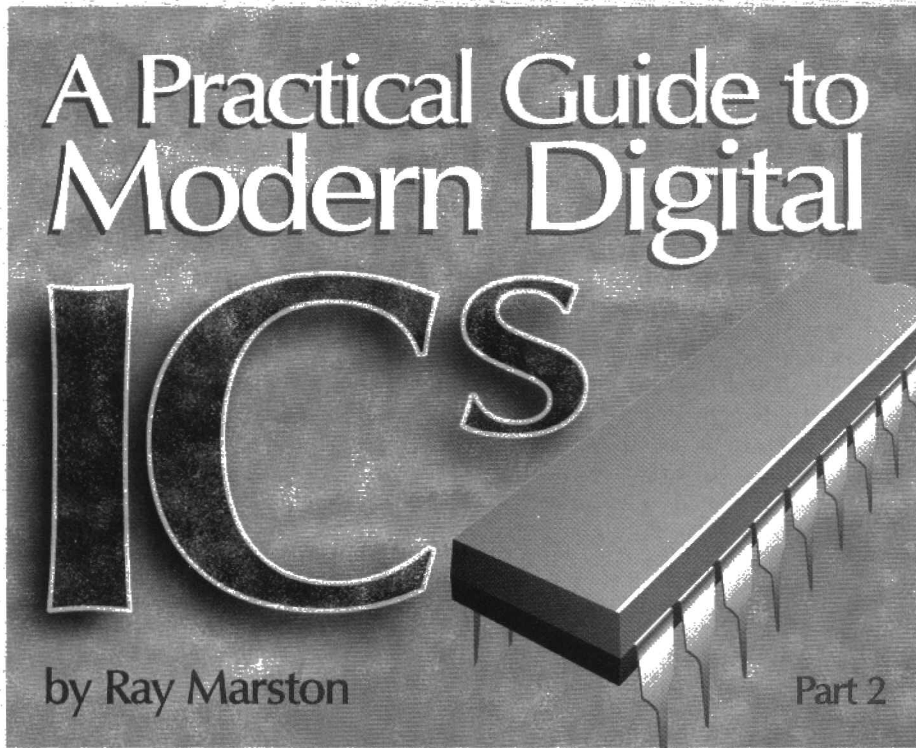


Last month, Part 1 looked at digital IC basics, and went on to describe basic logic IC families – including TTL and CMOS – and concluded with the '74-series' of ICs. This part takes a deeper look at the '74-series', and at various sub-members of the TTL and CMOS families.

The '74-series' of Digital ICs

Modern digital electronics is dominated by two major logic IC families, these being the low-speed '4000-series' of CMOS digital ICs, and the '74-series' of fast TTL and CMOS ICs. The '74' family was originally based entirely on TTL technology, which first hit the electronics scene in a big way in about 1972, when the '74-series' suddenly arrived in the form of an entire range of versatile and cleverly conceived TTL digital ICs, that were each designed to operate from a single-rail 5V supply and to directly and easily interconnect with each other without hassle (each output could directly drive several inputs), thus making it relatively easy for any moderately competent engineer to design and develop fairly complex digital logic systems. The series was an instant and brilliant international success, and almost immediately became the world's leading IC logic system. Its ICs were produced in both commercial and military grades, and carried prefixes of '74' and '54' respectively; the commercial product range rapidly became known simply as the '74-series' of ICs.

A major feature of the '74-series', is that all devices within the range function as 'black boxes' that operate at similar input and output threshold levels; the user does not need to understand their internal circuitry in order to use them, but simply needs to know their basic usage rules. Also, the input sensitivity or 'fan-in' of each device conforms to a fixed standard, and its output driving capability or 'fan-out' has a guaranteed minimum value, that indicates the number of external '74-series' inputs that it can safely drive directly, making it very easy to interconnect various devices; thus, the output of a '74' gate with a fan-out of 10 can directly drive as many as ten parallel-connected standard inputs on other '74-series' ICs.

The type of TTL technology used in the initial (1972) '74-series' ICs, resulted in a range of devices that were moderately fast but consumed fairly heavy currents. Within a year or so, sub-families of the original TTL were introduced, offering a trade-off between speed and power, i.e., twice the speed but at twice the current consumption (in the 'H' or 'high speed' sub-family), or one-tenth of the current consumption, but only one-third of the normal speed (in the 'L' or 'low power' sub-family), etc. This trend of seeking a good or ever-better trade-off between speed and power consumption has continued until the present day, and so far, a total of eight commercially successful sub-families of TTL (and five sub-families of CMOS) have appeared in the '74-series' of digital ICs. Many of these sub-families have subsequently become obsolete, but the practical design/maintenance engineer or technician still needs a basic knowledge of all of them, since he will often meet them in old equipment that needs repairing or upgrading.

Note that each sub-family of the '74-series' of ICs is almost directly compatible with all other sub-families in the series. Thus, if you open up an old piece of equipment and find (for example) that an old '74L90' decade counter IC needs replacing but is no longer available, you will probably find that a modern '74LS90' decade counter IC can be used as a direct plug-in replacement, or that any other '74XX90' ICs can be used as a replacement either directly or with slight circuit modification (depending on the basic characteristics of the two sub-families). In either case, the first thing that you will need to do is identify the device of interest, from its printed code number. Table 1 explains the basic scheme that is used in formatting the '74-series' code numbers.

All ICs in the '74' family are identified by an alpha-numeric code which, in its simplest form, consists of three sub-codes strung together as shown in Table 1. The first (left-hand) sub-code consists of 2-digits that read either 74, 54, or 75. '74' identifies the IC as a commercial-grade member of the family; these devices are usually encapsulated in a plastic, 14-pin, 16-pin, or 24-pin dual-in-line package (DIP), can be used with supplies within the limit +4·75 to +5·25V, and can be operated over the temperature range 0°C to +70°C. '54' identifies the IC as a high-quality, military-grade member of the family; these devices are encapsulated in exotic packages, can use supplies within the limit +4·5 to +5·5V, and can operate over the temperature range –55°C to +125°C. '75' identifies the IC as a commercial-grade, interface device, that is designed to support the '74' range of devices.

The second (central) sub-code consists of up to three letters, and identifies the precise technology or sub-family used in the construction of the device, as shown in the diagram. Note that standard TTL devices carry either no central code at all, or an 'N'; each of the other seven major TTL sub-family devices carry a central identifying code, and the five major CMOS '74' sub-families carry a central code that includes the letter 'C'.

The last (right-hand) sub-code usually consists of 2 to 5 digits (but occasionally includes a letter 'A' or a star), and identifies the precise

74 XXX 000

Family: (2 digits)	Sub-family: (0 to 3 letters)	Function: (2 to 5 digits)
74=Commercial	Blank/N=Standard TTL	
54=Military	L=Low-power TTL	
75=Interface device	H=High-power TTL	
	S=Schottky TTL	
	LS=Low-power Schottky TTL	
	AS=Advanced Schottky TTL	
	ALS=Advanced low-power Schottky TTL	
	F=FAST TTL (Fairchild ALS TTL)	
	C=CMOS version of TTL device	
	HCT=High-speed CMOS, with TTL-compatible inputs	
	HC=High-speed CMOS, with CMOS-compatible inputs	
	AC=Advanced high-speed CMOS	
	ACT=Advanced high-speed CMOS, with TTL-compatible inputs	

Table 1. Basic coding system used on the '74-series' ICs.

function of the IC (e.g., quad 2-input NAND gate, decade counter, 4-bit shift register, etc.). The precise relationship between this sub-code and the device function can be ascertained from manufacturer's lists, etc.

Thus, a '74' type of IC may carry a code that, in its simplest form, reads something like 7400, 74N00, or 7414, etc., if it is a standard TTL device, or 74L14, 74LS38, or 74HC03, etc., if it is some other sub-member of the '74' family. Note that in practice, '74-series' ICs often carry an elaborated form of the basic code that includes a two-letter prefix that identifies the manufacturer, plus a lettered manufacturer's suffix that indicates the packaging style, etc., as shown in Table 2. Hence, a device marked SN74LS90N is a normal 74LS90 IC, manufactured by Texas Instruments, and housed in a plastic dual-in-line package.

Basic '74-series' code

AA 74XXX000 ZZ

Manufacturer's Prefix;
- CD = RCA
- DM = National Semiconductor
- MC = Motorola
- MM = National Semiconductor
- N = Signetics
- PC = Signetics
- SN = Texas Instruments

Manufacturer's Suffix;
- N = Plastic dual-in-line package
- P = 8-pin plastic DIL package
- J = Ceramic package

Table 2. The basic '74-series' code is often elaborated with a manufacturer's prefix and/or suffix.

TTL Sub-families

Eight major sub-families of TTL have been used in the '74-series' throughout its lifetime, as follows:

Standard TTL. Similar to the basic type already described, except that each of its inputs is provided with a protection diode that helps suppress transients and speed up its switching action. Figure 1 shows the actual circuit of 7400 2-input NAND gate; its power consumption is 10mW, and its propagation delay is 9ns when driving a 15pF/400Ω load.

Low-power (L) TTL (now obsolete). A modified version of the standard type, with its resistance values greatly increased to give a dramatic reduction in power consumption at the expense of reduced speed. Figure 2 shows the circuit of a 74L00 2-input NAND gate; its power consumption is 1mW, and its propagation delay is typically 33ns.

High-speed (H) TTL (now obsolete). A modified version of the standard type, with its resistance values reduced to give an increase in speed at the expense of increased power consumption. Figure 3 shows the circuit of a 74H00 2-input NAND gate; its power consumption is 22mW, and its propagation delay is typically 6ns.

Schottky (S) TTL. A common-emitter transistor switch can be designed to give either a saturated or an unsaturated type of switching action. Saturated switching, in which the transistor's collector voltage falls far below that of the base under the 'on' condition, is very easy to implement, but produces propagation delays that are about 2·5 times longer than those available from unsaturated circuits. Standard TTL operates its transistors in a heavily-saturated switching mode in which the collector falls some 400mV below the base under the 'on' condition, and is thus intrinsically fairly slow. Schottky TTL (now obsolete), on the other hand, operates its transistors in a lightly-saturated switching mode in which the collector only falls some 180mV below the base

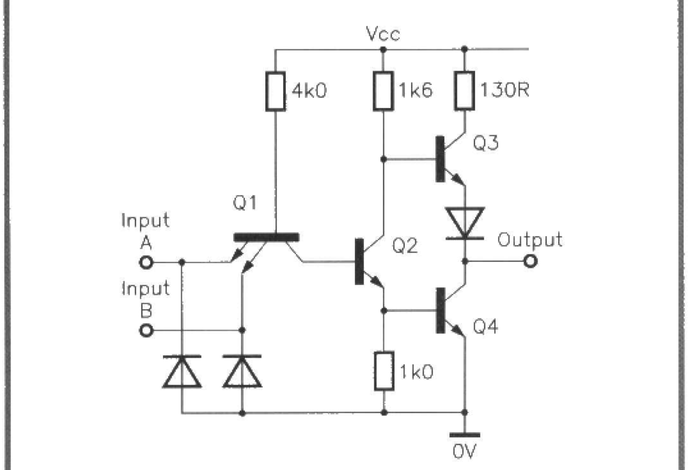


Figure 1. Circuit of a standard TTL 7400 2-input NAND gate.

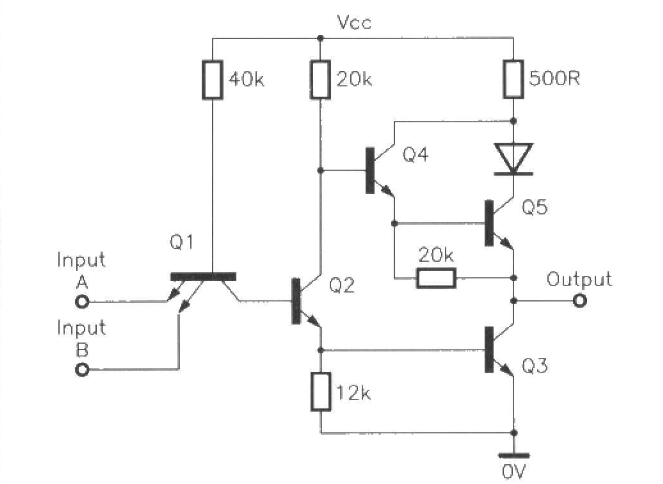


Figure 2. Circuit of a low-power (L) TTL 74L00 2-input NAND gate.

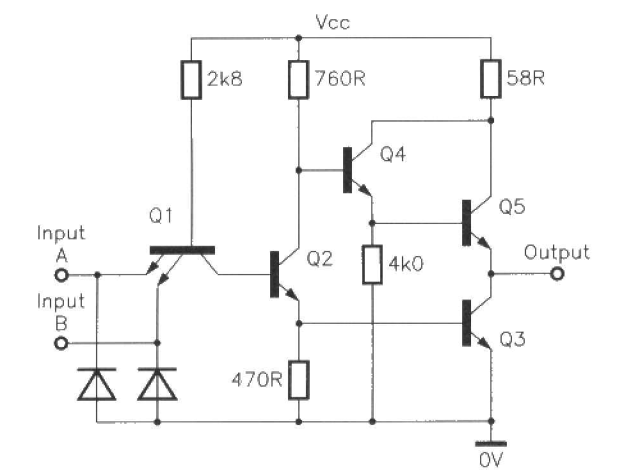


Figure 3. Circuit of a high-speed (H) TTL 74H00 2-input NAND gate.

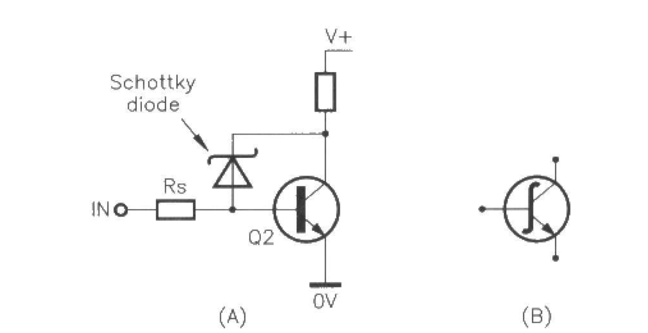


Figure 4a. A Schottky diode used to limit the saturation depth of an npn transistor.
Figure 4b. Symbol of an npn 'Schottky' transistor, with a built-in clamping diode between its collector and base.

voltage under the 'on' condition, and is almost as fast as an unsaturated circuit. Basically, this action is achieved by connecting a Schottky diode (which is fast-acting and typically has a forward volt drop of only 180mV) between the transistor's collector and base as shown in Figure 4a, in which Rs represents the input pulse's source impedance. Thus, if the collector goes more than 180mV negative to the base, the Schottky diode becomes forward biased and starts to shunt base current directly into the transistor's collector, thus automatically preventing deeper saturation. In reality, the Schottky diode can easily be incorporated in the transistor's structure, and a 'Schottky-clamped transistor' of this type uses the symbol shown in Figure 4b.

In a practical Schottky TTL IC, Schottky-clamped transistors are widely used, and most resistance values are reduced, thus giving a good increase in speed, at the expense of power consumption. The totem-pole output stage uses a Darlington transistor pair to give active pull-up, plus a modified active pull-down network that gives an improved waveform-squaring action. Figure 5 shows the circuit of a 74S00 2-input NAND gate; its power consumption is 20mW and its propagation delay is 3ns when driving a 15pF/280Ω load.

Low-power Schottky (LS) TTL. Uses a modified form of Schottky technology, using improved manufacturing techniques, combined with a 'diode-transistor' (rather than multi-emitter) form of input network that has a high impedance and gives fast switching. Figure 6 shows the circuit of a 74LS00 2-input NAND gate; its power consumption is 2mW and its propagation delay is 8ns when driving a 12pF/2kΩ load.

Advanced low-power Schottky (ALS) TTL. This sub-family is similar to LS, but uses an advanced fabrication process which, combined with minor design modifications, yields active devices that are faster and have higher gains than LS types. Figure 7 shows the circuit of a 74ALS00 2-input NAND gate; its power consumption is 1mW and its propagation delay is 4ns when driving a 50pF/2kΩ load.

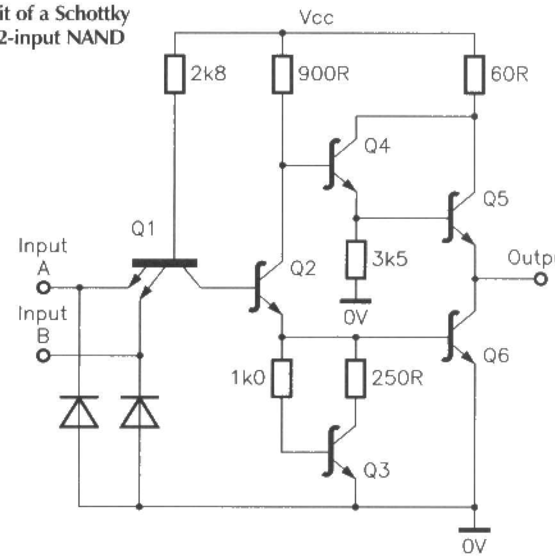
Advanced Schottky (AS) TTL. This sub-family is similar to ALS, but its design is optimised to give very high speed at the expense of power consumption. Figure 8 shows the circuit of a 74AS00 2-input NAND gate; its power consumption is 22mW, and its propagation delay is a mere 2ns when driving a 50pF/2kΩ load.

FAST (F) TTL (Fairchild Advanced Schottky TTL). Fairchild's version of 'AS' TTL. It is manufactured under license by several companies (including Philips and National Semiconductors); its performance is similar (in terms of speed and power consumption) to that of the AS sub-family.

CMOS '74-series' Sub-families

When the '74-series' of ICs were first released in 1972, all devices in the range were based on bipolar TTL technology, which inherently consumes a fairly large amount of power irrespective of its operating speed. In about 1975, the rival CMOS digital IC technology arrived on the scene, and although not as fast as TTL, it offered the outstanding advantage of having a power consumption that was directly proportional to operating speed, being virtually zero under quiescent conditions and rising to the same value as TTL at about 10MHz. In the

Figure 5. Circuit of a Schottky (S) TTL 74S00 2-input NAND gate.



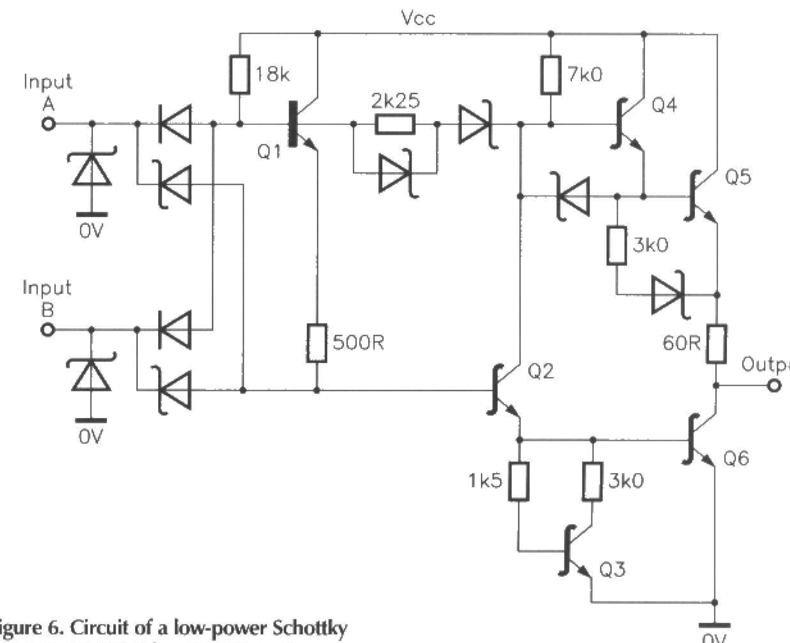
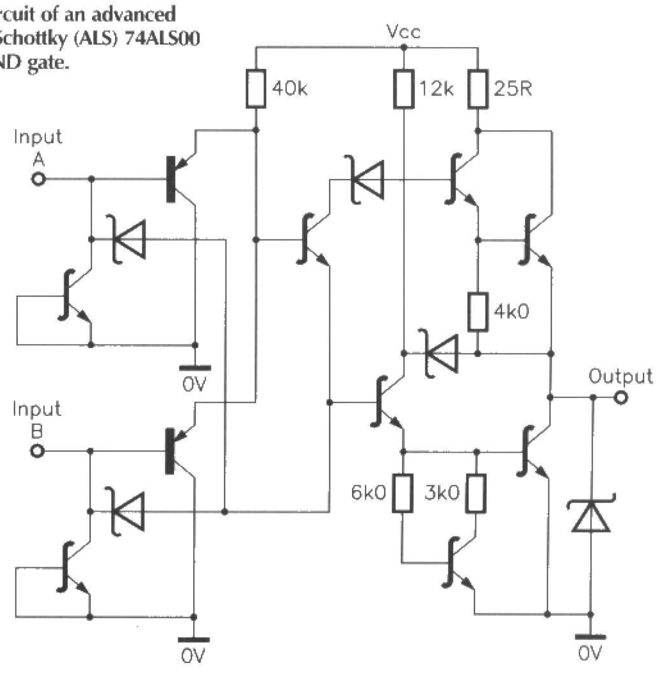


Figure 6. Circuit of a low-power Schottky (LS) TTL 74LS00 2-input NAND gate.

Figure 7. Circuit of an advanced low-power Schottky (ALS) 74ALS00 2-input NAND gate.



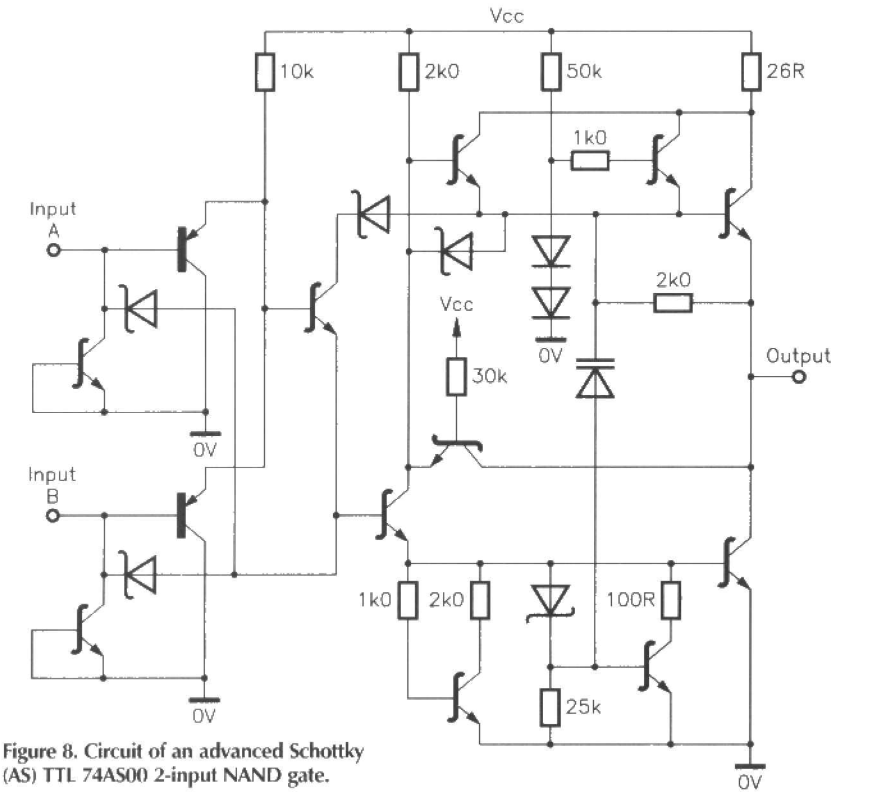


Figure 8. Circuit of an advanced Schottky (AS) TTL 74AS00 2-input NAND gate.

late 1970s, CMOS was introduced as a sub-family within the '74-series' range of devices, carrying the central code 'C'; the graph of Figure 9 compares the frequency/current-consumption curves of a single gate from the standard TTL and the CMOS 'C' versions of the 7400 quad 2-input NAND gate IC.

In its early form, the '74-series' 'C' sub-family was slow, and had poor output-drive capability (its fan-out drive was equal to two 'L'-type inputs). In subsequent years, however, many improvements took place in both the design and production of CMOS-type devices, and so far, a total of five CMOS sub-families have been introduced in the '74-series', as follows:

Standard (C) CMOS. This (now obsolete) sub-family was virtually normal CMOS, but in a '74-series' format. Typically, a single 74C00 2-input NAND gate consumed about 15mW at 10MHz, and had a propagation delay of 60ns.

High-speed (HC) CMOS. In the early 1980s, advances in CMOS manufacture yielded speed performances similar to LS TTL, but with CMOS levels of power consumption. HC '74-series' devices using this technology have CMOS-compatible inputs; typically, a single 74HC00 2-input NAND gate consumes less than 1μA of quiescent current, and has a propagation delay of 8ns.

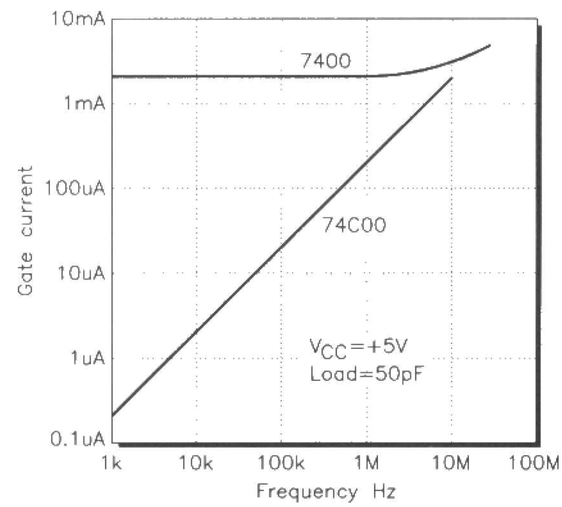


Figure 9. Frequency-current graphs of 7400 (TTL) and 74C00 (CMOS) 2-input NAND gates (with a squarewave input).

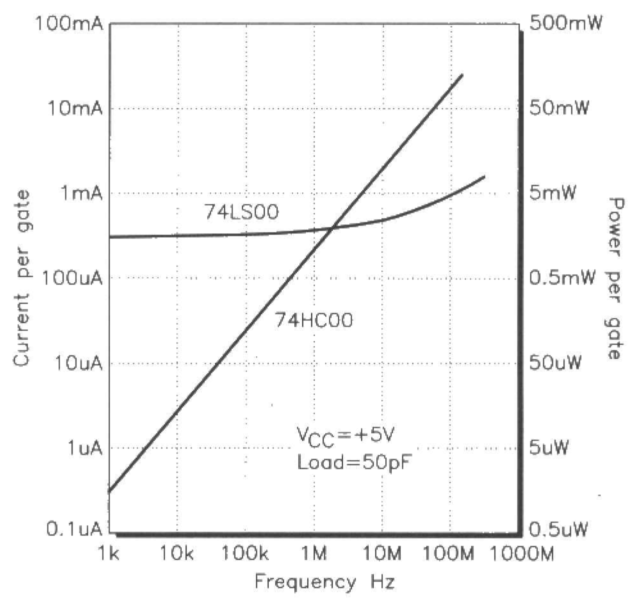


Figure 10. Frequency versus current/power graphs of 74LS00 and 74HC00 2-input NAND gates (with a squarewave input).

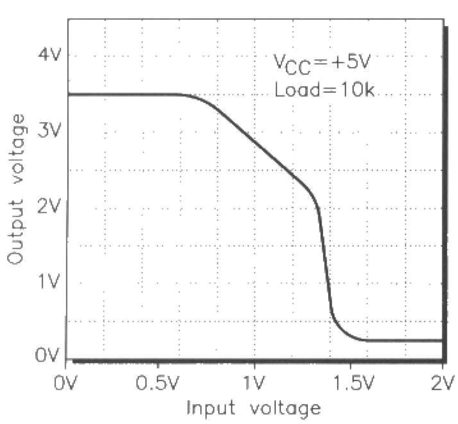


Figure 11. Standard-TTL input-to-output voltage graph.

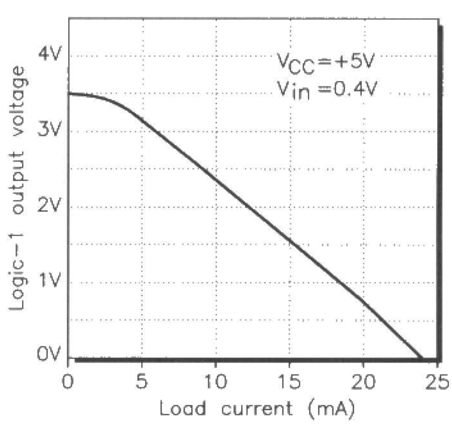


Figure 12. Standard-TTL 'logic 1' output voltage-current graph.

High-speed (HCT) CMOS. These are HC-type devices, but have TTL-compatible inputs. Typically, a 74HCT00 2-input NAND gate consumes less than 1μA of quiescent current, and has a propagation delay of 18ns.

Advanced high-speed (AC) CMOS. In the late 1980s, advances in CMOS design and further advances in CMOS fabrication techniques, yielded speed performance similar to those of ALS. AC '74-series' devices using this technology, have CMOS-compatible inputs; typically, a 74AC00 2-input NAND gate has a propagation delay of 5ns.

Advanced high-speed (ACT) CMOS. These are AC-type devices, but have TTL-compatible inputs. Typically, a 74ACT00 2-input NAND gate has a propagation delay of 7ns.

Which Logic Family is Best?

Two major general-purpose logic families are currently available, these being the '4000-series' low-speed CMOS family, and the high-speed '74-series' TTL/CMOS family (a third family, using emitter-coupled logic (ECL) technology, is very specialised, and is intended for use mainly in very-high-speed applications). The '4000-series' is of particular value in circuits operating below frequencies of a few MHz, in which a minimal figure of quiescent current consumption is desired; other major advantages of the series, are that its ICs can operate from any supply in the 3 to 15V range, have excellent noise immunity, and have ultra-high input impedances.

The '74-series' is of special value in circuits operating at frequencies up to several tens of MHz, in which low quiescent current consumption is not too important, and in which the ICs can be powered from a well-regulated DC supply (typically of +5V). If you decide to use a '74-series' IC, you are next faced with the problem of deciding, "Which sub-family is best for my application?"

Which '74-series' Sub-family is Best?

When designing a new logic circuit, ICs should always be selected on a basis of commercial (rather than purely technical) superiority. It would, for example, be foolish to use a really fast ALS gate in an application in which a slower LS or HC device would be perfectly adequate, and was easily available at a fraction of the cost of the ALS device. With this point in mind, note that the five '74-series' IC sub-families most widely available (at the time of writing) are standard and LS TTL, and HC, HCT and AC CMOS. Of these, standard TTL is technically and commercially inferior to LS, and is not recommended for use in new designs, AC CMOS cost approximately 2·5 times as much as LS TTL or HC/HCT CMOS and should thus only be used in special applications, and HCT is only meant to be used as a replacement for TTL devices in existing designs, and should not really be used in new designs. That leaves just LS TTL and HC CMOS.

Of these two '74-series' sub-families, LS is slightly faster than HC, and is available in a far greater range of functional device types, but generally consumes more supply current/power than HC at frequencies below about 5MHz (Figure 10 compares the performances of 74LS00 and 74HC00 gates). Thus, for most 'new design' applications, the LS TTL and HC CMOS sub-families deserve a joint 'best' award, with LS having a slight edge, perhaps. Note that the rest of this, and all of next month's article, are both concerned mainly with modern TTL devices, and CMOS devices will be dealt with next in Part 4.

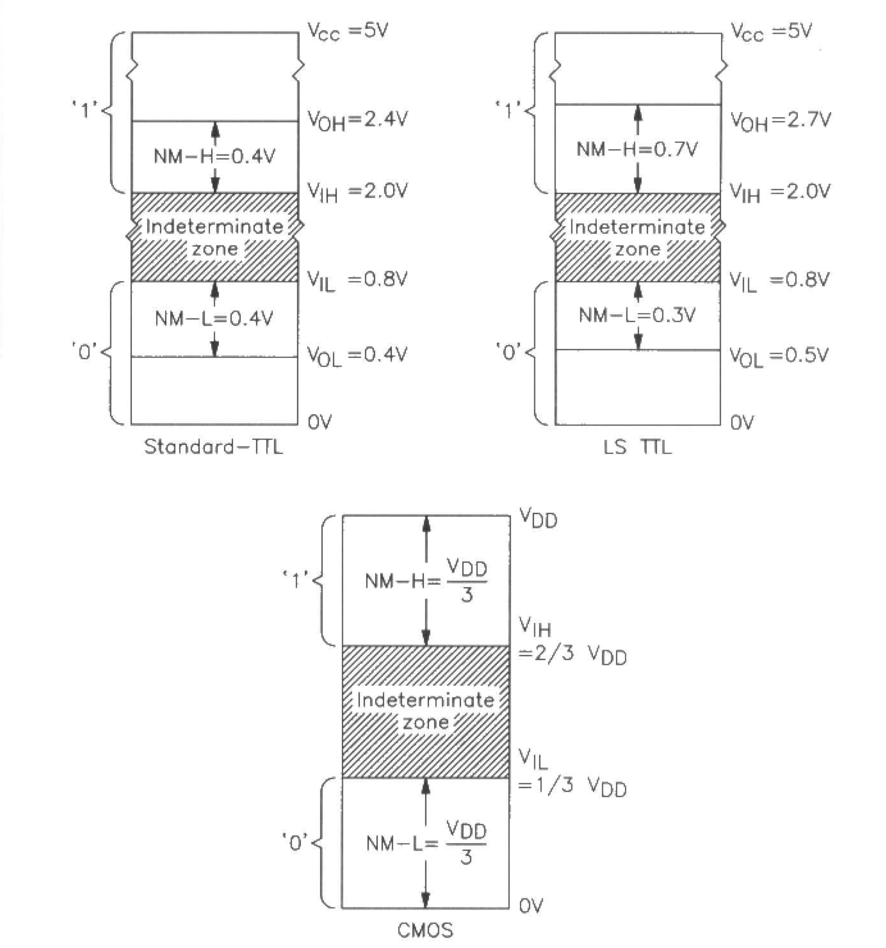


Figure 13. Logic level and noise margin values of standard TTL, LS TTL, and CMOS.

	'74-series' TTL Sub-families							
Parameter	**Standard**	**L**	**H**	**S**	**LS**	**AS**	**ALS**	**Units**
Propagation Delay (2-input NAND gate)	9	33	6	3	8	2	4	ns
Power Dissipation (per gate)	10	1	22	20	2	22	1	mW
V_{IH}	2·0	2·0	2·0	2·0	2·0	2·0	2·0	V
V_{OH}	2·4	2·4	2·4	2·7	2·7	V_{CC}-2V	V_{CC}-2V	V
NM-H	400	400	400	700	700	700	700	mV
V_{IL}	0·8	0·7	0·8	0·8	0·8	0·8	0·8	V
V_{OL}	0·4	0·3	0·4	0·5	0·5	0·5	0·5	V
NM-L	400	300	400	300	300	300	300	mV

Table 3. Typical propagation delay and power dissipation figures for single '00'-type NAND gates within the TTL sub-family ranges, together with sub-family voltage threshold and noise-margin values.

TTL Logic Levels and Noise Immunity

All digital ICs handle input and output signals that are in either the 'high' (logic 1) or 'low' (logic 0) states. In TTL, each of these 'logic levels' must fall within a well-defined range of voltages limits. Figure 11 shows the typical input-to-output voltage curve of a 'standard' TTL inverter that operates from a +5V supply and has a lightly loaded output. Note that the output is 'high', at +3·5V, until the input rises to 0·7V, and then falls fairly linearly as the input is further increased, and eventually stabilises at a 'low' value of about 0·25V when the input rises above 1·5V. In practice, all standard and LS TTL ICs are, when using a +5V supply, guaranteed to recognise any input voltage of up to 0·8V as being a logic 0 input, and of 2·0V or above, as being a logic 1 input; the area between these two levels is known as the IC's 'indeterminate' (forbidden) zone or region, and operation within this zone should be avoided.

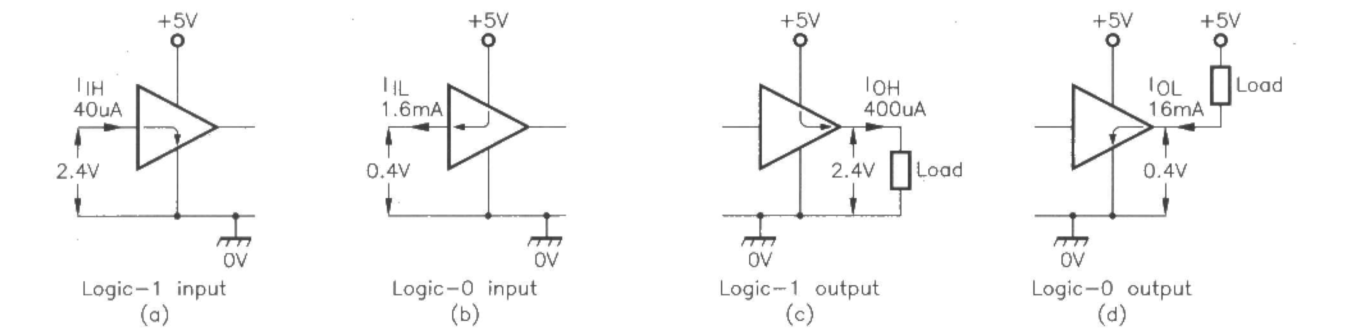


Figure 14. a, b, c, d. Basic input and output parameters of a standard TTL logic element.

In TTL circuitry, different logic levels are used to define input and output signals, since TTL output voltage levels vary considerably with loading conditions; Figure 12 shows how, when an input of 0·4V is applied to the above TTL inverter, the logic 1 output voltage falls from +3·5V at near-zero load current, to a mere 2·0V at a load current of 13mA, and so on. In practice, all standard TTL ICs are guaranteed (when using a +5V supply) to recognise any output voltage of up to 0·4V as being a logic 0 output, and of 2·4V or above, as being a logic 1 output; on LS TTL ICs, these levels are 0·5V for logic 0, and 2·7V for logic 1.

When one TTL output is connected directly to a following TTL input, any excessive 'noise' on the output signal may cause incorrect operation of the following input stage. Thus, taking a worst-case situation, a logic 1 standard TTL output may be as low as 2·4V, and any superimposed negative-going 'noise' pulse greater than 0·4V will drive the following input below the 2·0V 'logic 0' defined threshold and may cause it to erroneously recognise its input as being a logic 0 (rather than logic 1) signal. The maximum worst-case magnitude of noise that a digital IC can ignore under these conditions is known as its 'noise immunity' or 'noise margin' value, and equals the difference between the logic 0 or logic 1 output/input threshold values. With standard TTL, noise margins for both logic 1 (NM-H) and logic 0 (NM-L) have defined worst-case values of 400mV; with LS TTL, the noise margins are 700mV for logic 1, and 300mV for logic 0; with CMOS, both margins have values of $V_{DD}/3$. Figure 13 illustrates the values of these three sets of threshold and margin values.

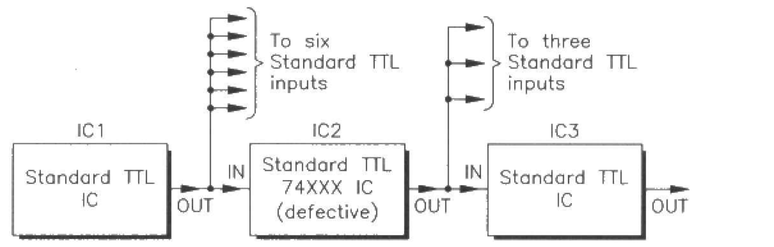


Figure 15. IC2 is defective; it is a standard TTL device. Can it be replaced directly by a 74LSXXX IC? Figure 20 shows that the answer is YES.

Table 3 expands the above information, and shows actual defined threshold voltage and noise margin values, together with typical propagation and power dissipation values for single '00' type, 2-input NAND gates, for the seven major sub-families of TTL (FAST TTL is regarded here as simply a minor variation of AS TTL).

	'74-series' TTL Sub-families							
Parameter	**Standard**	**L**	**H**	**S**	**LS**	**AS**	**ALS**	**Units**
I_{OH}	400	200	500	1,000	400	2,000	400	μA
I_{IH}	40	10	50	50	20	20	20	μA
Fan-out, H	10	20	10	20	20	100	20	–
I_{OL}	16	2·0	20	20	8·0	20	8·0	mA
I_{IL}	1·6	0·18	2·0	2·0	0·36	0·5	0·2	mA
Fan-out, L	10	11	10	10	22	40	40	–
Worst-case fan-out	10	11	10	10	20	40	20	–

Table 4. Fan-in and fan-out values of the major TTL sub-families.

	'74-series' TTL Sub-families						
Parameter	**Standard**	**L**	**H**	**S**	**LS**	**AS**	**ALS**
Fan-in, '1'	1	0·25	1·25	1·25	0·5	0·5	0·5
Fan-in, '0'	1	0·1125	1·25	1·25	0·225	0·3125	0·125
Fan-in, worst-case	1	0·25	1·25	1·25	0·5	0·5	0·5
Fan-out, '1'	10	5	12·5	25	10	50	10
Fan-out, '0'	10	1·25	12·5	12·5	5	12·5	5
Fan-out, worst-case	10	1·25	12·5	12·5	5	12·5	5

Notes:
Fan-in, '1' = IIH/40μA
Fan-in, '0' = IIL/1·6mA
Fan-in, worst-case = highest figure
Fan-out, '1' = IOH/40μA
Fan-out, '0' = IOL/1·6mA
Fan-out, worst-case = lowest figure

Table 5. TTL fan-in and fan-out in terms of 'Standard TTL' units.

Fan-in and Fan-out

In TTL circuitry, an element's input drive requirements are known as its 'fan-in' values, and its output driving capability limits are known as its 'fan-out' values. Figures 14a to 14d illustrate the meanings and worst-case values of these items when applied to a standard TTL element. Thus, Figure 14a shows that when the TTL element is driven from a standard TTL output stage, it draws a worst-case input current (IIH) of 40μA when fed with a 2·4V logic 1 input, but, as Figure 14b shows, feeds 1·6mA (IIL) into the driver when it provides a 0·4V logic 0 input. Figure 14c shows that the TTL element's output can, when in the logic 1 state, provide up to 400μA (IOH) before its output voltage falls below 2·4V; it is thus capable of feeding up to ten standard inputs, and is said to have a logic 1 'fan-out' (equal to IOH/IIH) of 10. Similarly, Figure 14d shows that the output stage can, when in the logic 0 state, absorb up to 16mA before its output voltage falls below 0·4V; it is

thus capable of driving up to ten standard inputs, and is said to have a logic 0 fan-out (equal to IOL/IIL) of 10. Thus, the element has a worst-case fan-out of 10, and it can be used to directly drive as many as ten standard inputs.

Table 4 presents the above data in tabular form, together with similar data for all other major TTL sub-families. When working within any one sub-family, note that the most important figure here is the 'worst case fan-out (F-O)' value. Thus, if you are (for example) designing a system based entirely on LS ICs, you can confidently connect an ordinary output directly to as many as 20 normal inputs, without risk of a malfunction due to overloading (if you need to drive more than 20 inputs, you can do so via one or more high-fan-out buffers, etc.). Note that, within any given sub-family, all ordinary inputs are said (in TTL jargon) to have a fan-in of unity (1), but that in practice, some MSI or LSI ICs (such as counters and registers, etc.) may have special inputs (such as Reset or Preset, etc.) with fan-in values of 2 or greater.

Sometimes, an engineer may have to mix TTL sub-families, usually so that an obsolete IC can be replaced by a readily-available, modern plug-in close-equivalent. In such a case, it is necessary to relate the fan-out data of one sub-family to that of another, to check that the mix can be made without causing an input or output overload. One easy way of doing this, is to simply transpose the data of Table 4 into 'Standard TTL' fan-in units, as shown in Table 5, to gain an approximate idea of the relative 'fan' values of various sub-families. Thus, it can be seen at a glance, that LS TTL has only half of the fan-in requirement of standard TTL, but also has only half of its fan-out capability, etc.

An even more useful way of using the basic data of Table 4, is to convert it into an easily used form that relates the fan-in and fan-out data of each TTL sub-family to all other TTL sub-families, as shown in Table 6. Here, by reading across the left-hand columns, it can (for example) be seen that a normal LS output can drive up to 5 standard TTL inputs, and that a standard TTL output can safely drive up to 20 LS inputs. Thus, if an engineer is faced with a problem such as that illustrated in Figure 15, in which a fault on an old standard TTL circuit is traced to a defective 74XXX-type IC (IC2) which is used to directly drive four other standard TTL inputs, it can be quickly seen that a 74LSXXX plug-in equivalent IC can be safely used to directly replace the standard TTL device without incurring overload problems.

Sub-family Drivers	Sub-family Inputs: Standard	L	H	S	LS	AS	ALS
Standard TTL	10	40	8	8	20	20	20
L	1·25	11	1	1	5·5	4	10
H	12·5	50	10	10	25	25	25
S	12·5	100	10	10	50	40	50
LS	5	40	4	4	20	16	20
AS	12·5	111	10	10	55	40	100
ALS	5	40	4	4	20	16	20

Note:
Fan-out = lowest figure of: $\frac{I_{OL}\text{ (driver)}}{I_{IL}\text{ (inputs)}}$ and $\frac{I_{OH}\text{ (driver)}}{I_{IH}\text{ (inputs)}}$

Table 6. Maximum number of TTL inputs that may be driven from any TTL sub-family output.

TTL Basic Usage Rules

It is usually a fairly easy matter to design logic circuity using TTL ICs, providing that a set of TTL basic usage rules are observed. Assuming that the matter of fan-in and fan-out has already been taken care of, there are four 'basic usage' themes outstanding, and these will be described in Part 3 next month.

UHF PRESCALER

This easy-to-build project has been designed to provide a simple, effective and economical means of extending the upper frequency measuring capability of older or lower-priced basic Digital Frequency Meters (DFMs), by as much as a factor of ten. This means, for example, that if you have a DFM with an upper frequency limit of 50MHz, the addition of this circuit to the input stage will increase this limit to 500MHz, enormously increasing the usefulness of the instrument, allowing you to measure unchartered territory within the frequency spectrum!

KIT AVAILABLE (90055) Price £18.99

THIS PROJECT COULD INCREASE YOUR DFM's FREQUENCY RANGE BY UP TO A FACTOR OF TEN!

The Assembled PCB UHF.

FEATURES

* Part surface-mount technology
* Compact and highly efficient design
* Wide operating voltage range
* AC or DC operation
* No calibration required

APPLICATIONS

* Extends the measuring range of Digital Frequency Meters
* For hobbyists, educational and development laboratories

2 PROJECT RATING

Design by Ben Spencer
Technical support by Nigel Skeels
Text by Ben Spencer and Maurice Hunt

The UHF Prescaler would be particularly beneficial for use with some of the 'new generation' Digital Multimeters (DMMs), many of which now incorporate a frequency-measuring function, albeit usually with a very limited range, only covering up to around 20MHz at best. The UHF Prescaler has additional uses other than purely for DFMs, for example, it could be used to obtain reduced output frequency from an oscillator or 'clock' stage, to give a more useful frequency signal for another section of a circuit. It could also be used in conjunction with an oscilloscope, to extend the measuring range when observing square or rectangular waveforms of logic circuits.

The circuit is compact, to facilitate its easy fitment into an existing instrument's casing, and gives both a taster of surface-mount construction and an insight into ultra high-frequency (UHF) circuit design. The project may be operated from a wide choice of power supplies, both AC and DC, and twin LEDs indicate the presence of an input signal, and that power is being applied.

Specification

Power supply:	9Vrms AC or 5 to 15V DC
Current consumption:	150mA maximum
Sensitivity:	350mV Pk-to-Pk @ 650MHz, 600mV Pk-to-Pk @ 40MHz
Maximum input voltage:	2·5V Pk-to-Pk
Output voltage:	TTL levels (5V)
Minimum input frequency:	40MHz (10MHz typical)
Maximum input frequency:	650MHz (800MHz typical)
Prescale ratio:	$F_{out}:F_{in}$ = 1:10
Visual indicators:	Power on and Clocking LEDs

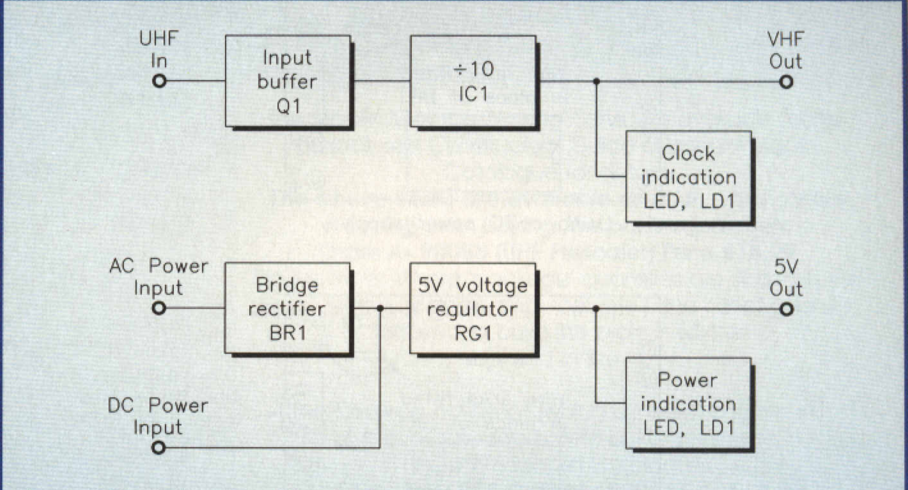


Figure 1. Block diagram of the UHF Prescaler.

Circuit Description

Refer to the block diagram, shown in Figure 1, and circuit diagram of Figure 2. The power supply stage comprises a

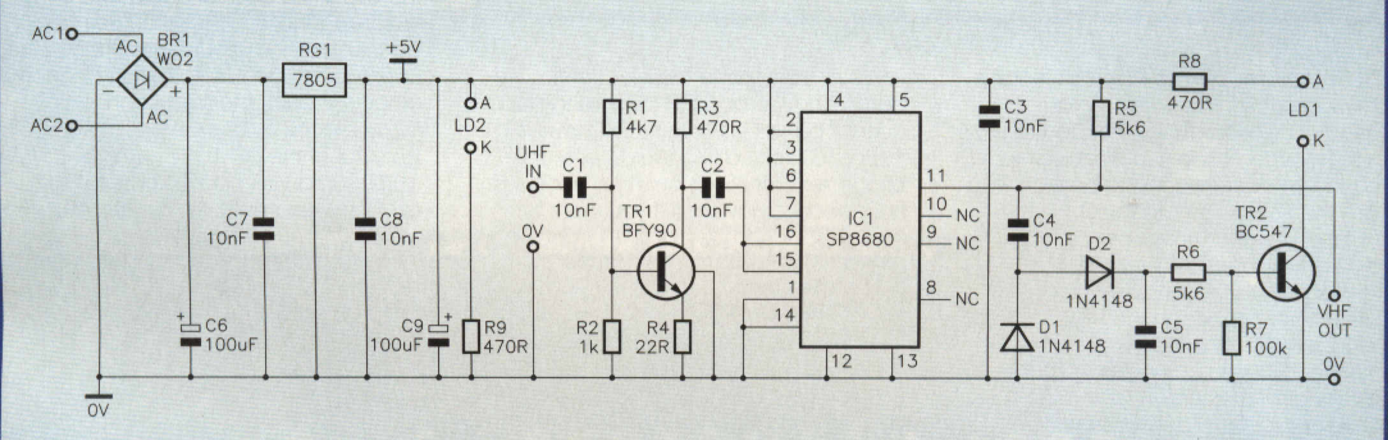


Figure 2. UHF Prescaler circuit diagram.

full wave bridge rectifier, BR1, reservoir capacitor, C6, high-frequency decoupling capacitor C7, and a 7805 5V regulator, RG1. The regulator output is decoupled by C8 and C9. LED LD2 is used to indicate when power is supplied to the circuit, with R9 as the current limiting resistor.

The input signal is coupled via C1 to the base of TR1, a bipolar high-frequency wideband amplifier transistor, biased in Class B configuration by R1 and R2. Note that this transistor has four leads, one being a 'screen' connection, in addition to the usual emitter, base and collector. R3 provides a resistive load, and the amplified signal is fed via C2 to pins 15 and 16 of IC1, an SP8680A frequency divider. The TTL level output from pin 11, is pulled up by R5, and is fed via the VHF output terminals to the DFM.

Part of the TTL output is tapped off via C4, and is fed to diodes D1 and D2, which with C5, form a half-wave voltage doubler. When a VHF/UHF signal has been prescaled and with the output ($^1/_{10}$th the input frequency) present on pin 11 of IC1, the voltage doubler stage drives transistor TR2 into saturation, lighting LD1, thus indicating that the prescaler is clocking the input signal. LD1 is extinguished during no input signal conditions.

PCB Construction

Refer to the circuit diagram of Figure 2, and the PCB legend and track, given in Figure 3. Prior to building up the board, decide which power supply option the application will require, and refer to Figure 4, which shows the various wiring configurations for the different supply types possible. Note that wire links are required for the DC supply options, in which case, they should be fitted first. The circuit is a mixture of conventional

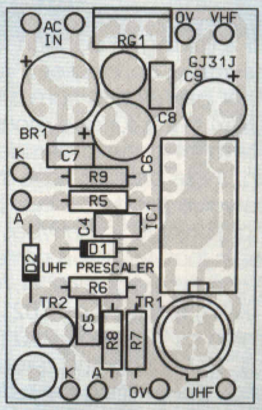
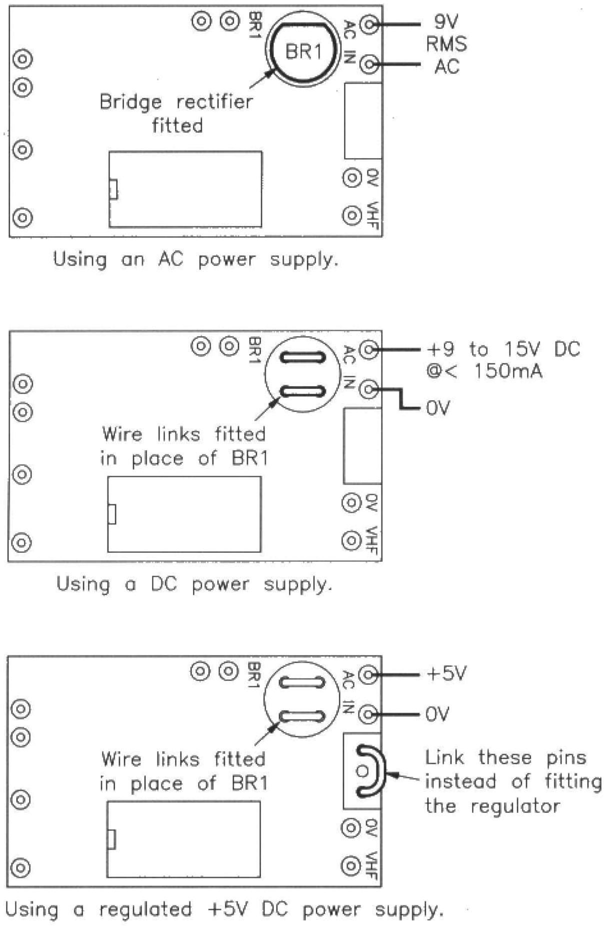


Figure 3. PCB legend and track.

and surface-mount components, the surface-mount devices (SMDs) being mounted on the underside of the board, and positioned in the area of TR1 and

Figure 4. Wiring diagram for different power supply options.



IC1, in the aim of keeping track lengths down to a minimum, which is an essential criterion of high-frequency circuit design. This in turn enables the maximum performance to be exploited from the frequency divider IC.

Fit the PCB pins (there are eight), followed by the resistors R5 to R9. Transistor TR1 is fitted next, ensuring it is pushed hard down on the PCB, so that the bottom of its casing is in contact with the PCB, prior to soldering all four pins (one for the screen connection) in the appropriate positions on the underside of the board. With this done, solder all round the lower perimeter of TR1's casing to the ground plane (on the topside of the board), so that there are no gaps. This provides a very high level of RF shielding (in addition to the transistor's screen connection!), to avoid problems of interference from other sources. Next fit the surface-mount resistors R1 to R4 to the underside of the board. These devices have the resistance value printed on their bodies, in a format similar to some types of disc capacitor, in that 4k7 (R1) is printed as '472' (47 and two zeroes, i.e., 4,700Ω = 4k7), 1k (R2) is printed as '102', 470Ω (R3) is printed as '471', and 22Ω (R4) is printed as '220' (22 and no zeroes, i.e., 22Ω). Follow this by fitting the surface-mount capacitors, C1 to C3, which are all 10nF, so you need not bother reading their values, just install them in the positions indicated for the SMD capacitors.

Fit diodes D1 and D2, observing their correct polarity, then the disc capacitors C4, C5, C7 and C8 (again, all the same value at 10nF), and the electrolytic capacitors C6 and C9 (observing the correct polarity). If you intend powering the circuit from a DC source only, then bridge rectifier BR1 is omitted, since it is not needed. However, if you want to operate the circuit from an AC source, fit BR1 at this stage, making sure it is mounted the correct way round; the terminals marked (~) are the AC inputs, while those marked (+) and (-) are the device's DC output terminals. Again, depending on the power supply arrangements you require, fit the voltage regulator RG1 (making sure it is the correct way round), or fit a wire link in place of this device for direct 5V DC operation.

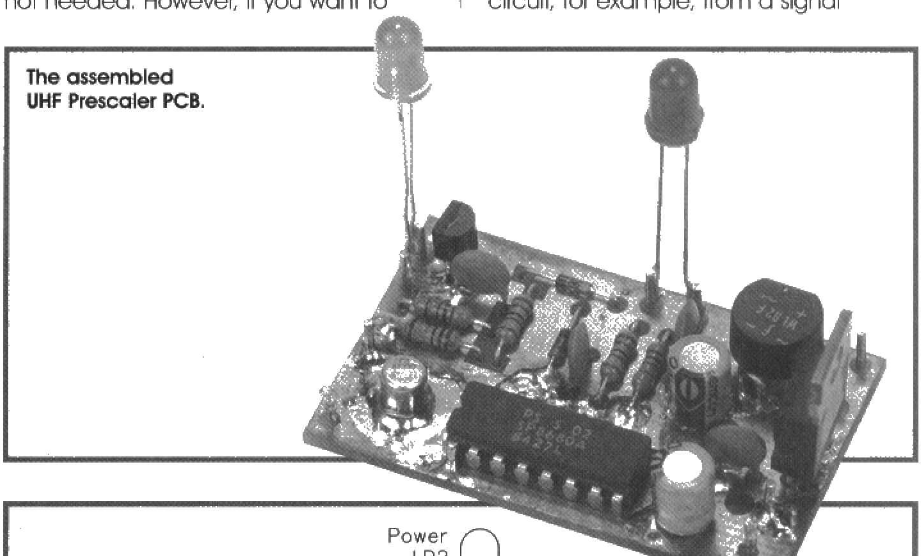
Also fit transistor TR2, which is mounted in the usual way (ensure it is fitted the correct way round). Finally, fit IC1 from the topside of the board, soldering all its pins to the underside pads, and pins 1, 12, 13 and 14 to the ground plane on the topside of the PCB. Check carefully for any errors in assembly, dry joints or solder whiskers, clean off any excess flux using a suitable solvent, then the testing of the board can commence!

Testing and Setting Up

Connect up a suitable power supply to the circuit, as illustrated in Figure 4, and ensure that the circuit current consumption does not exceed 150mA – if it does, switch off quick and recheck the board for faults. Connect the output to a DFM as shown in Figure 5. Connect a short length of wire to the prescaler UHF input, and connect the output of the circuit via coaxial cable to a DFM, observing that the 0V output terminal connects to the ground terminal on the DFM (via the coax screening), and the other UHF output terminal connects (via the coax inner core) to the input terminal of the DFM.

Feed in a VHF or UHF signal to the circuit, for example, from a signal

The assembled UHF Prescaler PCB.



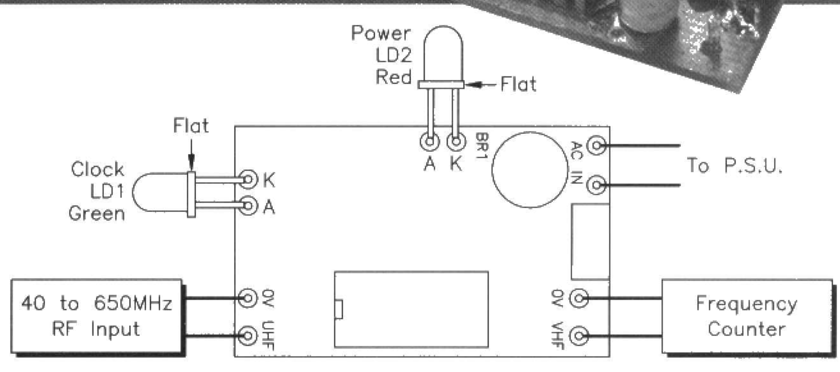


Figure 5. Wiring diagram for a typical installation.

generator, or by keying a 1·5W transmitter at a distance of about 1m away from the board. The DFM should now indicate a frequency that is 1/10th of the incoming signal frequency. Vary this frequency to check that the circuit operates at the specified upper and lower limits. If all is well, the circuit can be fitted into the DFM (or other application) itself, or can be fitted into its own separate enclosure.

At frequencies of 800MHz or more, the DFM reading may be erratic or give a zero reading. This indicates that the prescaler is not dividing by ten correctly, even though the Clocking LED might be lit. This is simply as a result of the upper limit of the SP8680A IC, which is only guaranteed by its manufacturer, Plessey, to operate at up to 575MHz, but normally operates to at least 300MHz above this figure – the prototype circuit was successfully operated at up to 900MHz.

UHF PRESCALER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)

R1	4k7 Surface Mount	1 Pack	(DJ15R)*
R2	1k Surface Mount	1 Pack	(DJ12N)*
R3	470Ω Surface Mount	1 Pack	(DJ10L)*
R4	22Ω Surface Mount	1 Pack	(DJ03D)*
R5,6	5k6	2	(M5K6)
R7	100k	1	(M100K)
R8,9	470Ω	2	(M470R)

CAPACITORS

C1,2,3	10nF SMD Ceramic	1 Pack	(DH97F)*
C4,5,7,8	10nF Metallised Ceramic	4	(WX77J)
C6,9	100μF 16V Radial Electrolytic	2	(RA55K)

*These devices are supplied in packs of 25 only.

SEMICONDUCTORS

D1,2	1N4148	2	(QL80B)
BR1	W02 Bridge Rectifier	1	(QL39N)
LD1	5mm Green LED	1	(WL28F)
LD2	5mm Red LED	1	(WL27E)
TR1	BFY90	1	(QQ64U)
TR2	BC547	1	(QQ14Q)
IC1	SP8680A	1	(GV14Q)
IC2	L7805CV	1	(QL31J)

MISCELLANEOUS

Single-ended PCB Pin 1mm (0·04in.)	1 Pkt	(FL24B)
PCB	1	(90056)
Instruction Leaflet	1	(XV78K)
Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As 90055 (UHF Prescaler) Price £18.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1996 Maplin Catalogue

UHF Prescaler PCB **Order As 90056 Price £3.99**

THE CONSUMER ELECTRONICS SHOW

This is an incredibly exciting exhibition that **you simply must not miss** – you will kick yourself if you do! LIVE '95 will feature some 200 of the most innovative companies in the UK involved in information technology, who will be demonstrating the very best of their latest products and services, in one mind-blowingly spectacular event, and one that will be sure to thrill all the family.

There genuinely is something for everyone at the show, with plenty of entertainment laid on in addition to the many new gadgets being demonstrated. Television and radio coverage of the event will feature strongly, with such institutions as *Carlton TV*, who are staging a live programme, 'After 5', hosted by Caron Keating on Tuesday and Wednesday between 5.05pm and 5.35pm, *Capital 95·8FM*, and *Kiss 100FM*, who are running the stage area for the ground-shaking in-car entertainment (ICE) tournament, and who will provide a five-hour entertainment package, with challenges, celebrities and great music! Look out also for TV's *Gladiators* – flexing their muscles in the company of seven leading photographic companies – the mind boggles!

All the up-to-the-minute technological 'in-things and whizz-bangs' are going to be given a mighty good airing, ranging from ultimate audio systems for the home and car, through to amazing computer products and games, mobile communications, exhilarating new leisure equipment, safe-as-houses security systems, and of course, lots of lovely, droolworthy electronics innovations!

To run a few more names past you, on the computing front, there will be interactive, multi-media stands from the likes of *Apple*; *BT* – who will host an Internet Café; *Demon Internet*; *Franklin*, with their range of portable databank products; *Microsoft*; and *Nintendo*, who will be showing off newly released games, such as "Killer Instinct" for the SNES, and the Super Game Boy, a sure-fire hit with fun lovers everywhere. If cars are your bag, then check out stands from the *Automobile Association*, who will have a Lotus concept car for the future; *Alpine*, who will be sporting BMW Compacts packed with ICE (now that's cool!) for free demonstrations, along with the 130dB Alpine sound room; *Audiotronics*, who are showing out in their Earthquake and Macrom vans, plus many other makers of superb ICE and car security products. The *Sound Challenge Association* are to host the national sound-off challenge at LIVE '95, where the top 120 cars in the land will battle it out, blaring monster sounds for prizes across the two days that the sound-offs are to be held. Home Hi-Fi companies will include *Denon*, exhibiting an award-winning range of Hi-Fi separates, mini/micro systems, home cinema and professional gear, and who are launching three new systems; *Sony*, who are showing their Play Station and MiniDisc music systems; and *Wharfedale*, who are demonstrating their new Valdus range of loudspeakers. A *Dolby* Home Cinema Promenade is a walk-through showcase representing six different ways of installing the full cinema effect in your own home, also involving *JVC, Kenwood, Polk, Sharp and Toshiba. Sharp* will additionally be holding a Star Toddler Competition! If you fancy a return to a bygone era, visit the *Sound Leisure* stand, who have a stunning selection of craftsmen built, replica 1940s jukeboxes, complete with dancing champagne bubbles and ever-changing coloured displays, to set off the polished walnut cases. And if you simply cannot bear to be out of touch, you will be interested in trying out the mobile communications products, from firms such as *Orange, Mitsubishi, Motorola, Nokia*, and *Talkland*.

And naturally, *Maplin Electronics* will be there with a very exciting stand, promoting the all-new, full colour 1,100+ page Maplin Catalogue, featuring a huge range of tremendous new products, including such diversities as computing, cycling, and telecommunications devices. Demonstrations will comprise of Global Positioning Systems (GPS) and the *Traffic Master* system, plus from *Sinclair*, the Zeta electric power booster for bicycles will be on show – and Sir Clive Sinclair himself will be in attendance on our stand on Saturday, 23rd September.

See for yourself all that's fresh, new, exciting and downright brilliant in the world of consumer electronics, and beat a path down to LIVE '95 – you won't believe your eyes and ears, it's truly that spectacular!

PLUG INTO PCMCIA VERSATILITY

by Martin Pipe

The mobile computing revolution is gathering pace, and its impact on the world of computers can be compared to that of mobile telephones on the telecommunications industry. Indeed, as we shall discover, the two technologies are merging. Notebook computers and personal digital assistants (PDAs) are now gathering an increasing share of the overall PC market, and their portable nature now means that work can be carried out anywhere, regardless of whether a mains power supply is present or not. The finishing touches to a report can be made on the train, prior to that all-important meeting, and complex multimedia presentations can be shown by salespeople to a number of potential customers, without the hassle of setting up equipment beforehand. Mobile computers are fast being seen as an important productivity tool.

Unfortunately, until fairly recently, there has been no peripheral bus standard for portable computers, which makes expansion difficult. Although the first bulky laptops available had a limited number of ISA slots for accepting standard desktop PC expansion cards, the smaller machines that followed did not have the room to accommodate such cards. Users of the first notebooks had to connect their machines, via serial or parallel ports, to bulky mains-powered peripherals often larger than the computers themselves, or plug standard PC expansion cards into a 'docking station', which essentially converted the machine into a desktop PC and destroyed the benefit of portability. Hidden under a flap, an increasing number of modern notebooks and PDAs provide an answer to this technological straitjacket, in the form of at least one 68-pin PCMCIA peripheral slot, which is designed to accept specially designed peripherals of the same dimensions as a thick credit card.

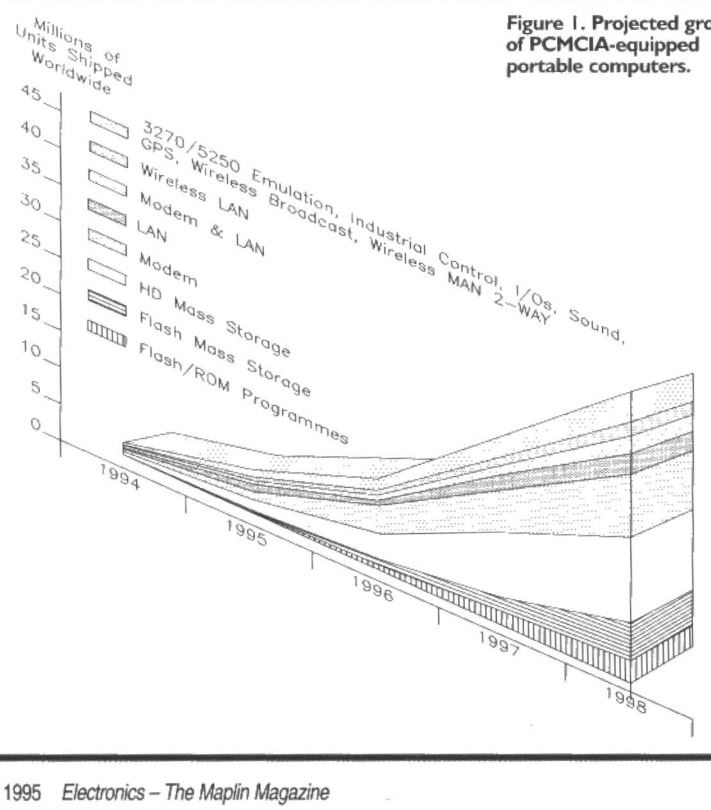


Figure 1. Projected growth of PCMCIA-equipped portable computers.

A year ago, these connectors were confined to expensive top-end machines of equivalent capabilities to the most powerful desktop machines then available. The fairly inexpensive RISC-powered Apple Newton, the first commercially available PDA, was an exception, being equipped with the technology from the outset. PCMCIA slots are now filtering their way down to basic models such as 486SX notebook PCs, and it will not be long before virtually all portable computing devices are equipped with them. According to analysts at the Gartner Group, 98% of all hand-held, and 78% of all notebook computers, will support at least one slot by 1997. The same analysts point out that PCMCIA will have the same effect on mobile computing as the ISA bus did on desktop machines in the 1980s. The projected growth of PCMCIA-equipped portable computers is shown in Figure 1.

PCMCIA – A Panacea for all Ills?

What is PCMCIA exactly, what are its benefits for users, and what peripherals are available? PCMCIA is, in fact, an acronym for the California-based Personal Computer Memory Card International Association. This is an independent and non-profit making body set up in 1989, to create internationally accepted specifications for credit card-sized peripherals of low power consumption for portable computers. Over 475 companies are members of PCMCIA, contributing to the definition of technical standards and sponsoring comprehensive marketing programmes. They include organisations with the industrial musclepower of Microsoft, Intel, IBM, Compaq and Toshiba.

The first PCMCIA specification, Release 1.0, which came in 1990, dealt with memory only – hence the name of the organisation. In 1991, came Release 2.0, which broadened the specification by adding I/O and execute-in-place (XIP) capabilities. The latter means that software loaded into a card's memory space is executable without having to load the program into the host's memory – in other words, it does not encroach on the computer's system memory.

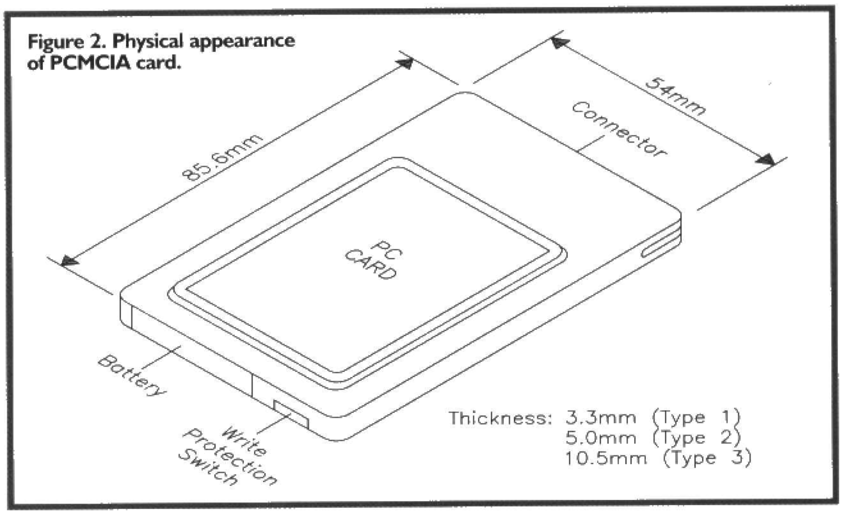
Release 2.0 increased the flexibility of the system,

waking up the computer industry, since it made possible a wider range of peripherals, including mass-storage media (hard disk drives), fax-modems, network cards, RF communications peripherals (such as wireless LANs) and multi-media devices, such as sound-cards and frame-grabbers. The specification that followed, Release 2.1, was simply a typographical correction of Release 2.0. The latest standard, finalised by PCMCIA and JEIDA (the Japanese Electronic Industry Development Association) in late 1994, is known as 'PC Card', presumably to make it more understandable to the general public. PC Card has been introduced to provide support for 3·3V cards and PCs, multi-function cards (such as combined LAN and fax/modem) and power management to increase battery life. No doubt, some confusion will arise, since the media-friendly name of the new standard is being used to lump together all PCMCIA cards. All standards are backwards-compatible, providing completely harmonious operation between the growing number of cards and compatible products. The comparison of pros and cons of PCMCIA cards is outlined below.

Card Types

As shown in Figure 2, all PCMCIA cards have the same length and width, and are 3·3mm thick along the guide rails and connector ends, so that they can be inserted into any PCMCIA slot, provided that it has the required vertical clearance. Cards come in three vertical sizes. Type I cards are 3·3mm thick, and are commonly used for memory applications. Type II cards are 5mm thick, which gives sufficient volume to accommodate the componentry used in fax/modems and network cards. There are also 'extended' Type I and Type II cards, which are 50mm longer, and are used where more room is needed for additional components, or if connections to the outside world require projection

Figure 2. Physical appearance of PCMCIA card.



from the slot. Type III cards, at 10·5mm thick, are typically used for hard disk drives and wireless communications devices. Any PCMCIA card will fit into a Type III slot, while a Type II slot will hold only Type I and Type II cards. There are no plans to introduce a Type IV card, which is just as well, bearing in mind the ever-decreasing size of notebook computers! The various card types are summarised in Table 1. Because the connection pins in the card slot are of different lengths (the power pins are longer than the signal pins, which in turn, are longer than the card detect pins), cards can be removed or swapped while the host machine is powered up. This is known as 'hot swapping'.

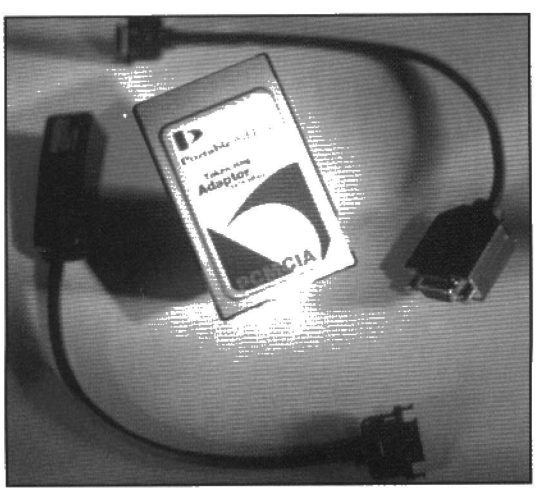
The PCMCIA bus standard has not been designed to replace the existing 8/16-bit ISA and 32-bit local buses used in desktop PCs, but to complement them. Indeed, there is a plug-in 16-bit PC expansion card, known as

PCMCIA Advantages

Low power consumption.
Small size.
'Plug and play' – automatic card recognition and configuration.
'Hot-swapping' – you can remove or replace cards with others, without a reboot.
Transparent to the user.
No messing with interrupts or individual software drivers.
Backwards-compatible.
Platform-independent.
Avoids duplication of resources within a company.

Disadvantages

Currently expensive – but prices are falling.
Card driver TSR programs cut the available conventional memory for DOS applications, unless card-specific enabler is used.
Cards can be difficult to insert and release – better slot designs required for notebooks.
Some users report compatibility problems with certain cards.
'Plug and play' not guaranteed.



Bottom left: PCMCIA Token Ring Adaptor, from Portable Add-ons.

Version	Width	Length	Thickness (Interconnect area)	Thickness (Substrate area)
Type I	54	85·5	3·3	3·3
Type I (extended)	54	135·6	3·3	3·3
Type II	54	85·6	3·3	5·0
Type II (extended)	54	135·6	3·3	5·0
Type III	54	85·6	3·3	10·5

Table 1. PCMCIA card dimensions (all measurements are in mm).

Cardport ISA, that provides desktop PCs with Type II and Type III PCMCIA slots, one of which sits in a 3·5in. drive bay. The cards currently available have a 16-bit data bus, a 25-bit address bus, and a maximum access speed of 60M-bit/s. Meanwhile, the new PC Card standard (known as 'Busmaster') offers 32-bit data and address buses. With bus speeds of 33MHz (which translates to access speeds of up to 80M-bit/s), Busmaster will yield enhanced performance with high-powered microprocessors such as Power PC and Pentium. PCMCIA is host-independent, and as such, is the only bus standard that works with Apple, PC and Sparc platforms.

Talking to the World

As can be seen from the pie chart of Figure 3, communications forms the greatest share of the PCMCIA market at present. A wide range of Hayes-compatible fax/modems, built into Type 2 cards, are currently available. The most popular at present are V.32bis devices, capable of data transmission (and Group 2 facsimile communication) at rates of up to 14·4K-bit/s before compression. Portable Add-ons, a company based in Guildford, Surrey, recently launched the UK's first V.34 PCMCIA fax modem, which can transfer uncompressed data at 28·8K-bit/s. V.32bis fax modems are available from Psion Dacom, US Robotics, Apex Data and Dataflex Designs. The units will plug into any nearby telephone socket, and adaptors are available so that they can be used on virtually any telephone system world-wide. An advantage for the user is that the high-speed serial interface required for reliable communications at fast data rates is already built into the card.

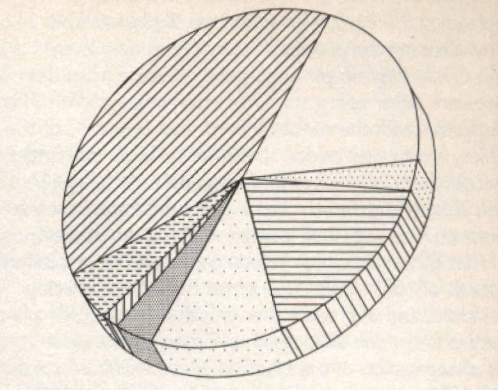
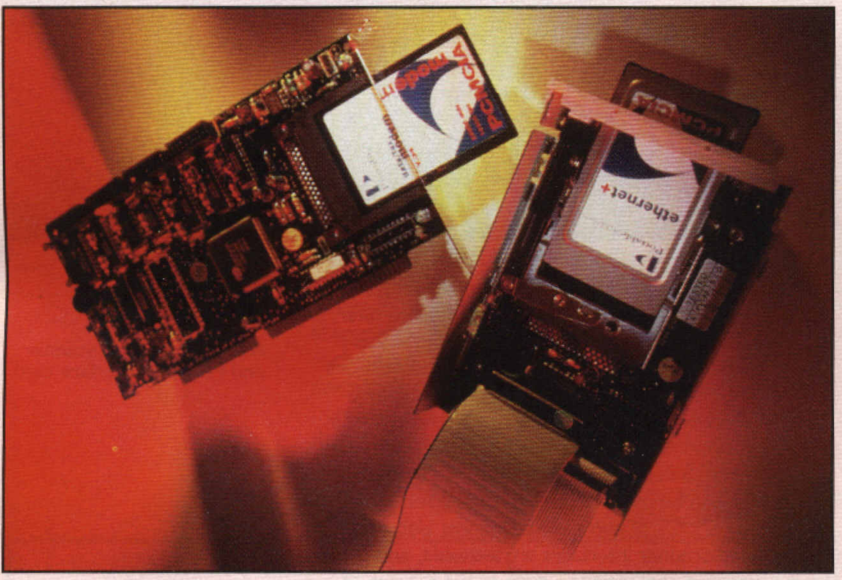
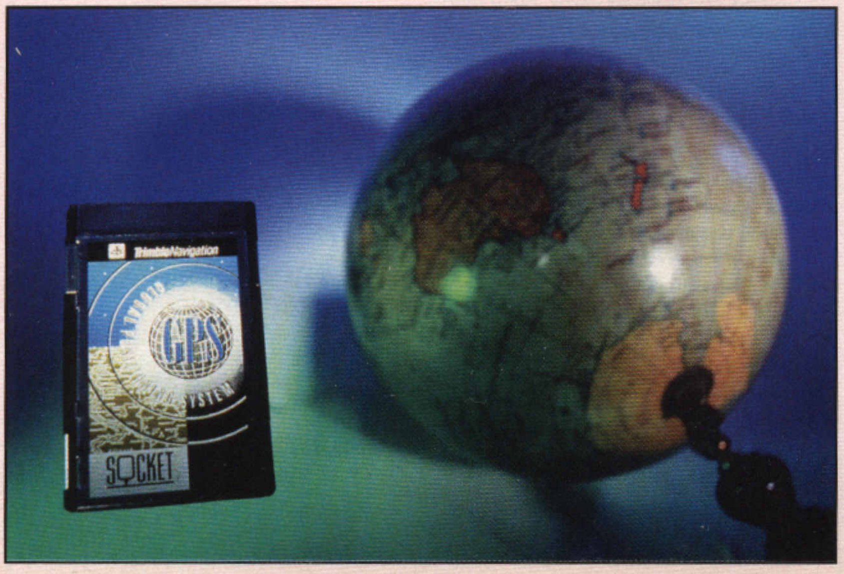


Figure 3. 1994 PCMCIA product mix.

Below: Cardport with ISA Bus, for linking PCMCIA to a desktop PC.

Bottom Left: Global Positioning System (GPS) PCMCIA Card.





All that may be fine, but a portable computer connected to a landline? That limits portability, doesn't it? Yes, but if you possess a mobile telephone, you have greater freedom in voice communication, so why not data as well? Many such phones are equipped with accessory ports, normally used for the attachment of 'hands-free' car kits. With a suitable adaptor, completely portable data communications can take place. E-mail and documents can be reliably transmitted anywhere within reasonable distance of a cellsite – great news for the much-hyped 'road warriors'. Remote access of the office mainframe can also be achieved. Unfortunately, moving from one place to another necessitates cellsite switching, and corrupts data – data transmission from a motorway-bound car is, therefore, a no-no! In addition, rates are limited to a somewhat sluggish 2·4K-bit/s before errors start to creep in. Vodafone has recently launched Vodata for its GSM digital service, and this provides reliable data communication at 9·6K-bit/s. PCMCIA GSM adaptors, albeit expensive, are available from Nokia for its current range of compatible phones. Others will follow as GSM takes off, which is likely, since Cellnet has just launched such a service, breaking Vodafone's monopoly and (hopefully) bringing down costs for the user.

There are also ISDN (Integrated Services Digital Network) adaptors, which will work at rates of up to 9 times faster than a V.32bis modem, when connected to the office ISDN line. These represent the current state-of-the-art, and are used by those who need to transfer large volumes of data (such as DTP and database files) quickly. Again, your mobile computer is tied down to a land-line. Greater promise of mobility, coupled with high throughput, is shown in the Hiperlan system, currently being finalised by the IEEE in the US, and ETSI (the European Technical Standards Institute) in Europe. This system, a wireless LAN or WAN (depending on the implementation) will make data rates of at least 30M-bit/s possible, and is scheduled for use on frequencies of around 5·2GHz. Various implementation schemes are envisaged for Hiperlan, including wide-area access (with repeaters possibly set up at cellular repeater sites) and local-area access, which is intended for wireless data communication within the confines of a building. One of the first Hiperlan-compliant designs, known as Hiperion, is being worked on by Advanced RISC Machines (ARM), Apple and GEC Plessey Semiconductor (GPS). Based around a user terminal contained within a single PCMCIA card, the system is planned for launch in late 1995.

Conventional cabled LANs are also well catered for by PCMCIA cards, and are a particularly valid use of the technology. Mobile users can plug their notebook

PCs into the office LAN when they are on site, uploading the day's work from the file server and downloading the previous day's. When they leave the office, they simply unplug the machine from the network (after telling the LAN operating system!) This dispenses with the requirement for an extra PC at the office, which may seldom be used. LAN connectivity standards include Ethernet (coax and twisted-pair) and Token Ring, which offers a better performance at present. This may well change with the introduction of Fast Ethernet, which will be capable of transmission speeds of 100M-bit/s – ten times that of the existing standard, and of greater use with the anticipated networked video services. Fast Ethernet will be a good application of the planned 32-bit PCMCIA cards. PCMCIA network cards are available from a number of manufacturers and distributors, including 3Com, Grey Cell Systems, Portable Add-ons and New Media Corporation.

Finally, we have PCMCIA cards which equip portable computers with additional serial interfaces (RS232 or RS422), SCSI-2 for hard disks, tape back-up devices or CD-ROM, and IEEE-488 general-purpose interface bus for the interface of test equipment, such as spectrum analysers, logic analysers and oscilloscopes. Manufacturers and distributors of such items include Adaptec, New Media, Empire, Portable Add-ons and Q-Logic.

Memory and Mass Storage

The first application of PCMCIA was memory cards. Today, there are Type I flash memory cards, available in capacities between 1M-byte and 40M-byte. These are treated as RAMdisks – in other words, pseudo-disk drives without the mechanically derived limitations in access time. Some even have write-protect switches, rather like the protection lugs on floppy disks. Since they are treated as disk drives, compression software such as Superstor and Stacker can be used to double the capacity. Unlike conventional RAMdisks, which occupy extended or expanded memory, PCMCIA memory cards are non-volatile and can be unplugged without losing data, and then locked away or transferred to other computers if required. Memory cards also have applications in 'fast programming' systems – for example, installing files or software in a company's entire notebook fleet.

That's not to say that flash memory is perfect. Since you cannot change the data at an individual address, a whole block of memory must be erased. To get around this problem, software (like Microsoft's Flash File) transfers the block to system memory, where it is modified before being reloaded back into the flash. A Type II flash card manufactured by Sundisk, takes a different approach, in that it has a built-in memory controller chip to juggle it all around. Other memory technologies available, include conventional static RAM, backed up by a 3V lithium battery, and one-time-programmable (OTP) memory. Japanese manufacturers such as Panasonic and Mitsubishi are particularly active here.

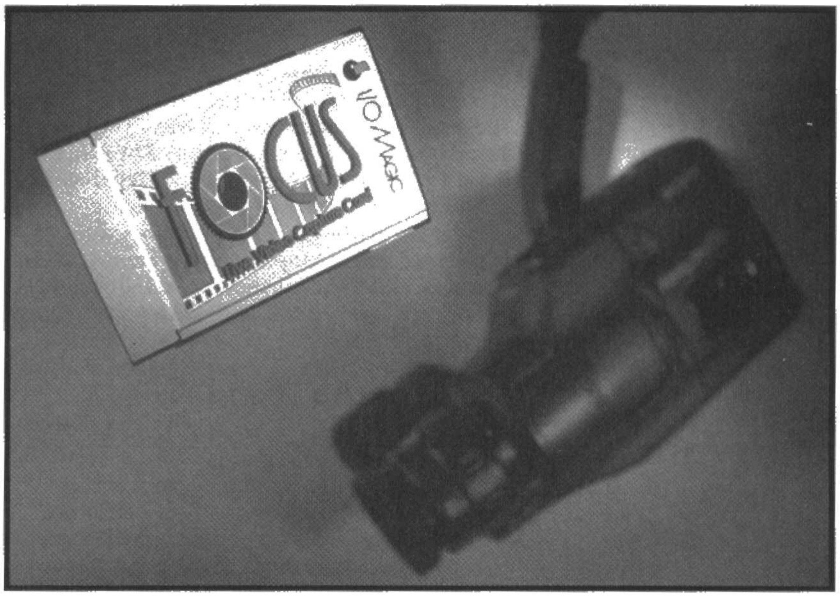
Conventional disk drives, built into Type III cards, are available with capacities currently ranging from 85M-byte to 170M-byte. Like the memory cards, these devices (which make use of tiny media with a 1·8in. platter) can be locked away for security, switched from one machine to another, and augment any disk drive already present in the host computer. Maxtor are heavily involved with the manufacture of PCMCIA disk drives.

Multimedia Cards

Notebook computer users have often yearned for the audio and video capabilities that are now bestowed upon desktop machines. Apart from enhancing games, they have serious uses in presentations and voice recognition. To this end, there are now PCMCIA sound cards on the market. Both 16-bit stereo record/playback and Soundblaster-compatible FM-synthesis are available, and some cards also offer MIDI terminals – great for the musician who wants to use his notebook as a sequencer! Portable Add-ons has recently introduced a live motion video capture card, which will display video as a small 'screen' within Microsoft Windows, and can also be used for frame-grabbing from a number of sources. Grabs from a camcorder can be used in 'on-line catalogues', or for distributing photos of company personnel electronically. Finally, hand-scanner interfaces are available, and these have numerous applications – such as the storage of documents and business cards. New Media Corporation, Panasonic and I/O Magic are amongst those who produce PCMCIA multimedia cards.

Weird and Wonderful

Spyrus, a Californian company, is responsible for a product which could have been tailor-made for portable computers which, if stolen, are lost with information that could prove disastrous for an individual or company, if it were to fall into the wrong hands. Lynks, a PCMCIA-based encryption system, is built around a 32-bit RISC-based single-board computer. Lynks is used to provide access to encoded files, which could be held on a hard disk or CD-ROM; the idea being that the card is kept in a safe place when the computer is not in use. Access to the information is only granted when the correct algorithm (CAPSTONE), stored within Lynks, is provided. Since all of the information on the drive is encrypted (a directory would reveal gibberish) the Lynks card has to work in real-time, unscrambling data as it is required. This is why a powerful processor (an



Top Right: Video Caption Card

Above: Hand-held scanner and PCMCIA interface card.

ARM 610) is used. Apart from security, the system is also intended for distribution of high value software, photo-libraries and classified e-mails.

A PCMCIA global positioning system (GPS) has been co-developed by Socket Communications, one of the world's largest card manufacturers, and Trimble Navigation, a major supplier of GPS products. GPS is a $12billion satellite-based positioning and navigation system, maintained by the US Department of Defence. It gives users world-wide access to round-the-clock and highly accurate, weather, position and velocity information. The interface is contained within a Type II card, while the RF electronics and microstrip aerial are contained in another unit. Portable Add-ons, the UK distributor, is including the famous Autoroute for Windows package with the system, which has numerous applications in surveying, disaster assistance, land, sea, and air navigation.

For those with desktop PCs who wish to avoid duplicating a collection of peripherals, there are PCMCIA interfaces. The already-mentioned Cardport ISA fits into a PC, but there are also external devices, such as the MC-Disk from MPL, which connect to any computer equipped with an SCSI port, and maintain the PCMCIA goal of platform independency.

PCMCIA Hardware Technology

Cramming the circuitry used into the cards described is no mean feat, and takes advantage of modern design and manufacturing methods. It does mean that such peripherals are not cheap. A V.32bis modem can now be picked up for around £120; its PCMCIA equivalent will set you back nearer £300. However, costs are falling.

The three essential technologies that make PCMCIA practical, are custom ASICs, surface mount components, and multilayer PCBs, and these are evident from the disassembled fax-modem card shown in the photograph. They are also widely used in the manufacture of notebook PCs and PDAs.

ASICs (Application-Specific Integrated Circuits) used in PCMCIA cards, contain not only a microprocessor macrocell, but also related circuitry, such as dedicated interface circuitry and cache memory. This allows the design to be implemented on fewer chips, with savings in space and power consumption. RISC processors, such as the 32-bit ARM610, are proving popular, since they are based around fewer transistors, and so consume less power and space on the chip die. Inside the PCMCIA host computer, is an ASIC chip which has overall responsibility for interfacing the unit's processor to the card. These devices, manufactured by companies such as Cirrus Logic, Texas Instruments, Motorola and Intel, are sadly incompatible – software is used to restore compatibility, and maintain PCMCIA's universality.

Surface mount technology, which is now standard electronics manufacturing practice, makes use of smaller design packaging with fine lead-out pitches, and is well suited to automated assembly. The devices are glued onto the PCB, the pads of which are covered with solder paste. When the board is passed through an infra-red heat source at a controlled rate, the solder melts and the connections are made. This process is known as reflow soldering. Both sides of the PCB are often used, particularly in the case of memory cards.

Multilayer PCBs consist of several track layers separated by insulating material, typically fibreglass, and can be much smaller than their double-sided counterparts, since the board designer can spread out the track over several layers, using vias to connect them where necessary. Whole layers are dedicated for power and signal distribution, and a ground plane.

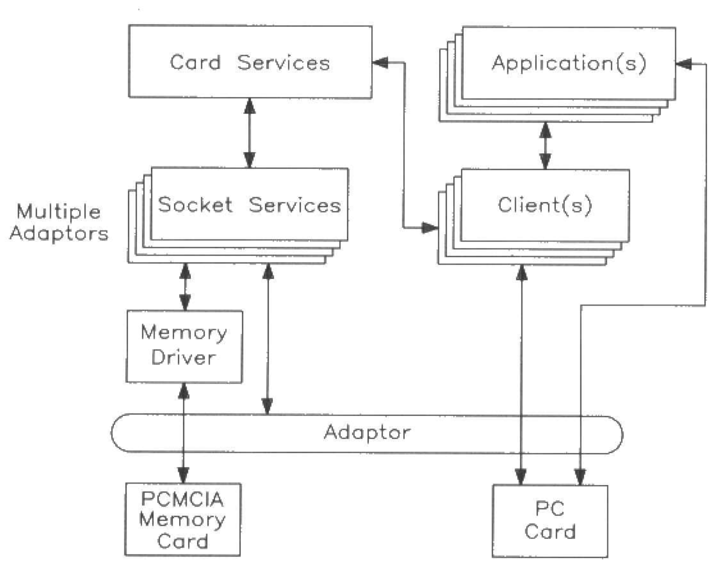


Figure 4. PCMCIA architecture.

Software

PCMCIA has been designed to be easy to use; apart from 'hot-swapping', cards should be easy to install and configure. This 'plug and play' philosophy means that you should be able to plug a card into a machine, without the need for further configuration – other than in special instances, such as modem settings and hard-disk initialisation.

This ease of use is made possible by three software layers, shown in Figure 4. The first, Socket Services, provides a standard interface for the different PCMCIA controller chips. Each controller chip has its own Socket Services driver. Eventually, this program will reside in the host computer's BIOS, but for now, it must be installed from disks supplied with the machine.

The second layer, Card Services, communicates with Socket Services, and maintains a table of system resources. This is crucial in situations where more than one card is being used. Like Socket Services, Card Services drivers are supplied with the host machine.

The third (and final) layer are the Card Clients, which make possible the idea of 'plug and play'. When a card is inserted into or removed from the slot, Card Services will inform the relevant Card Clients. The Card Clients will then take the appropriate action, configuring applications as a card is inserted, or informing applications if the card is removed.

A development of the Card Client is the 'Super Client', or Generic Enabler, which attempts to recognise and configure any card that is inserted. This is made possible through the interrogation of data stored in non-volatile memory on the card – a PCMCIA requirement, known as the Card Information Structure (CIS). The data included within the CIS, includes the card type and manufacturer, voltage and current requirements, allowable interrupts and addresses, memory timings and manufacturing information. The Generic Enabler will then interrogate Card Services to find out which resources are available, before instructing Card Services to configure the newly inserted card, without fear of clash.

If you are only using the one card, there is an alternative to this three-tier structure. Card-specific enablers, supplied by the card manufacturer, enable the device to talk directly to the PCMCIA controller, or via Socket and Card Services, if they are installed. Using card-specific enablers obviates the need for redundant Card Clients and Card Services, freeing up to 100K-bytes of system memory.

It is understood that new operating systems will be supplied with PCMCIA modules, the integration leading to higher performance. Chicago (Windows 4.0) makes use of interface programs written by Systemsoft, who also supply PCMCIA equipment manufacturers, as well as marketing a commercially available package, called Cardsoft+.

Continued on page 72.

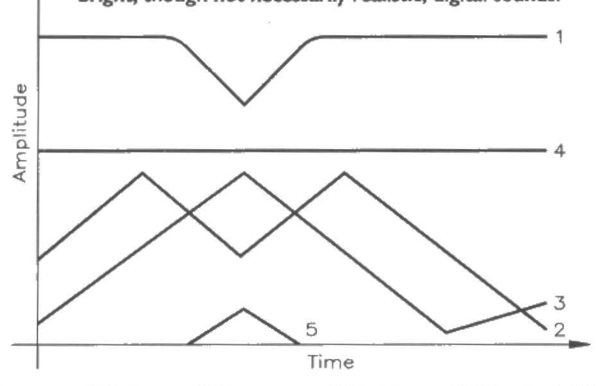
by Richard Wentk

The ART of Electronic Music

Part 3 – The Art of Sampling

In Part 2 of this series, we looked at the beginnings of digital synthesis. Although these early methods of sound creation were capable of interesting results, even the most ardent enthusiast would be hard-pressed to claim that they sounded anything like real acoustic instruments. So, a number of designers started to traverse another route. What was needed was a technology that was easy to use, easy to understand (which FM synthesis certainly was not) and capable of excellent results.

Figure 1. Additive synthesis works by specifying level curves for different harmonics. Although scientifically thorough, it is too fiddly for regular use, and tends to result in clean and bright, though not necessarily realistic, digital sounds.



THE solution came about almost by accident. In Australia, Peter Vogel and Kim Ryrie (older readers may remember Peter Vogel as one of the designers of the original Maplin range of synthesizers) had been working towards a comprehensive synthesizer design of their own. The original plan was to build a polyphonic analogue machine. However, on a chance trip to the Canberra School of Music, they came across the QASAR, an early digital synthesizer prototype.

After much design work, the QASAR turned into the Fairlight Computer Musical Instrument, the first widely available, general-purpose computer music workstation. The Fairlight was unusual in that it was capable of additive synthesis. In additive synthesis, sounds are created by adding together harmonics directly. The programmer defines a range of amplitude curves for each harmonic, and then the computer calculates the resulting waveform, as illustrated in Figure 1. The Fairlight used a variation on this idea, which stored successive waveforms in a table and then stepped through them, to produce complex changes in the final sound, as shown in Figure 2.

The sound data was stored in 16K-bytes of dynamic random access memory (DRAM). One of the system's designers realised that it was possible to use this RAM to store sounds recorded directly from the real world. So, he added a simple analogue to digital converter, plugged in a microphone, persuaded his dog to bark, and the world's first digital sampler was created – see Figure 3.

Although the technology behind sampling has evolved since those early days, the underlying principle remains the same. A sample is simply a recording of a real sound, captured in digital form. The sampler hardware is used to transpose the pitch of this sound up and down (in fact, the recording could just as well have been made on tape, and then the tape playback speed varied to create the same effect, but digital hardware is used for reasons of convenience).

To understand how samplers work, it is necessary to understand something of the theory of sound sampling, and how the different parameters involved affect the final result. Fortunately, the basics of sampling are very straightforward. To sample a sound, we measure its amplitude at regular intervals and then store the measurements in RAM, as indicated in Figure 4. To recreate the sound, the measurements (which are known as samples) are read out of the memory, and then converted back into a varying voltage, as per Figure 5.

The quality of the results depends directly on two things: how finely we measure the incoming waveform, and how often we sample it. The first, known as the resolution, defines the signal-to-noise ratio (SNR). The second, known as the sampling rate, sets the maximum possible frequency response. Because sampling is a digital process, inevitably we lose some of the details of the original waveform along the way. Because each measurement has to be rounded up to the nearest available digital equivalent, measurements which fall within the gaps are made with slight inaccuracies. This has the effect of introducing noise (known as quantisation noise) into the sampling process. The finer the resolution, and the more bits we use to represent the measurements, the less of a problem this noise will be, as Figure 6 clarifies.

The maximum possible signal-to-noise ratio of a digital system is around 6dB per bit. So, a system with an 8-bit resolution can never manage better than 48dB, while a 16-bit system can never improve on 96dB. These are theoretical limits, and in the real world it is hard to reach these figures, because any circuit includes other, more conventional, sources of noise. But good design makes it possible

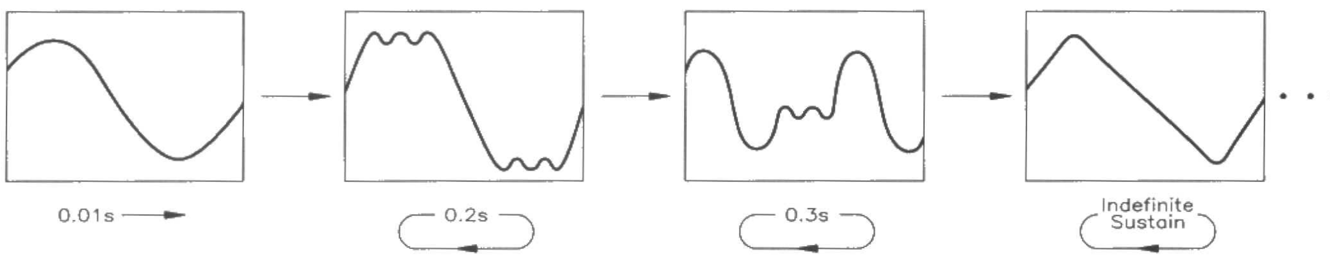


Figure 2. The Fairlight CMI used wavetable scanning for its sounds. After the waveform had been calculated using additive synthesis, it was placed in a table and then played for a fixed time. Then the next waveform section would be played, and so on.

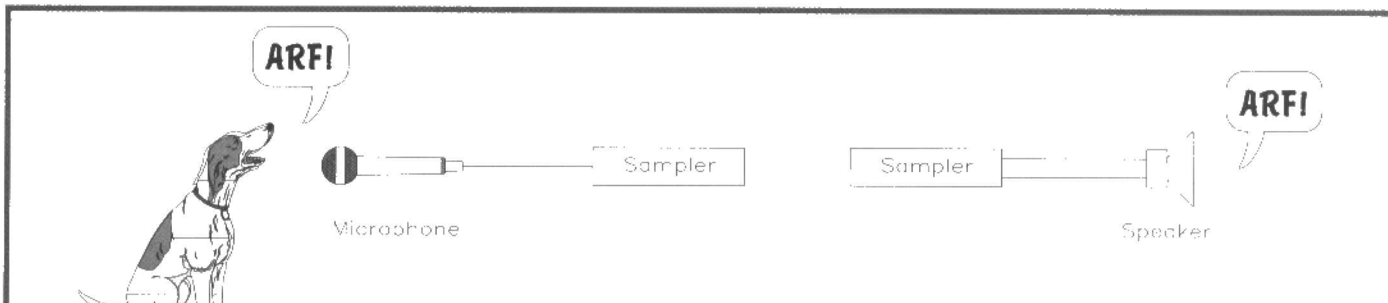


Figure 3. The birth of sampling took place when the first sampler was used to make a digital recording of a dog, belonging to one of the designers.

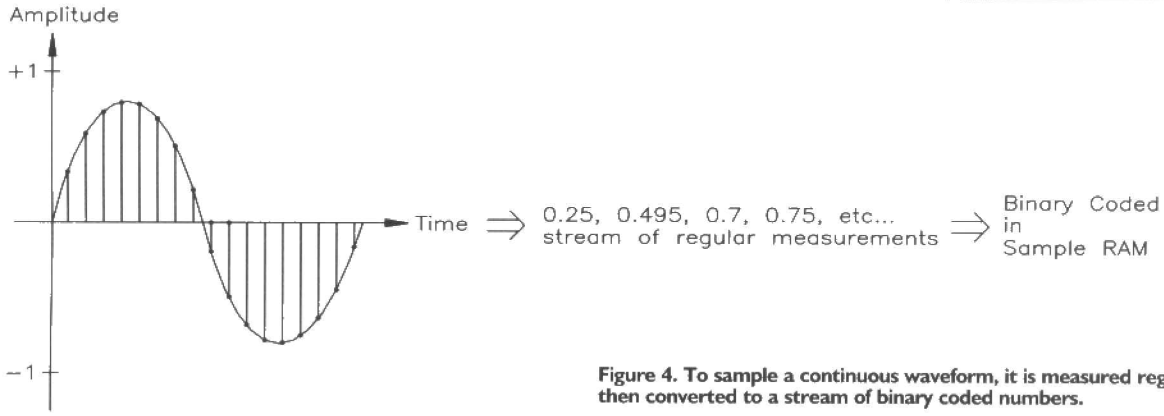


Figure 4. To sample a continuous waveform, it is measured regularly and then converted to a stream of binary coded numbers.

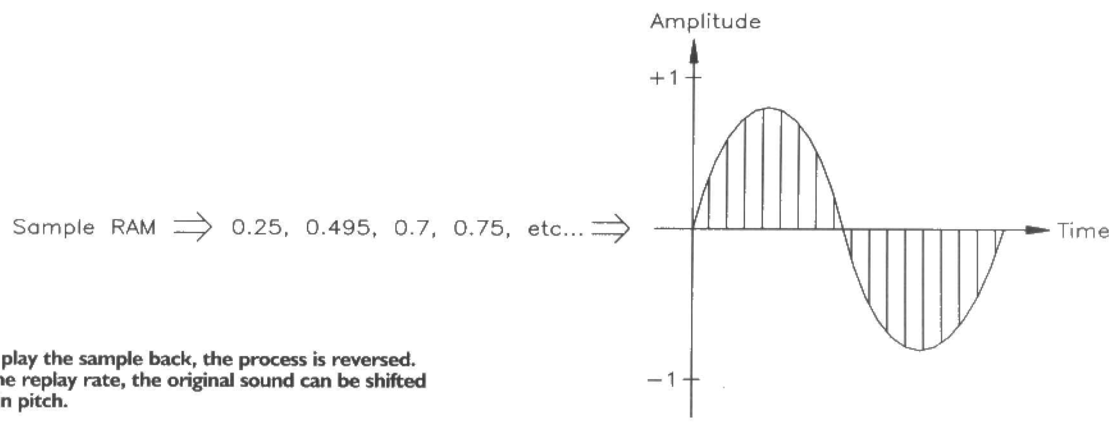


Figure 5. To play the sample back, the process is reversed. By varying the replay rate, the original sound can be shifted up or down in pitch.

to approach these figures closely. See Table 1 for additional information.

But what about frequency response? The rule of thumb here is based on the famous Nyquist Sampling Theorem, which states that if a signal with a maximum frequency of f is being sampled, the sampling has to be done at a rate of 2f or higher. In other words, if a sampler is to cover the full audio range of 20Hz to 20kHz, it has to be able sample at a minimum of 40kHz.

If this rule of thumb is ignored, a peculiar phenomenon known as aliasing takes place. This wraps the out-of-range frequency components of the sampled signal back into the sampled frequency band, creating a discordant, distorted sound. The effect is the audio equivalent to that created when a forward-moving vehicle's wheel appears to rotate backwards on a film or TV. The visual sampling rate

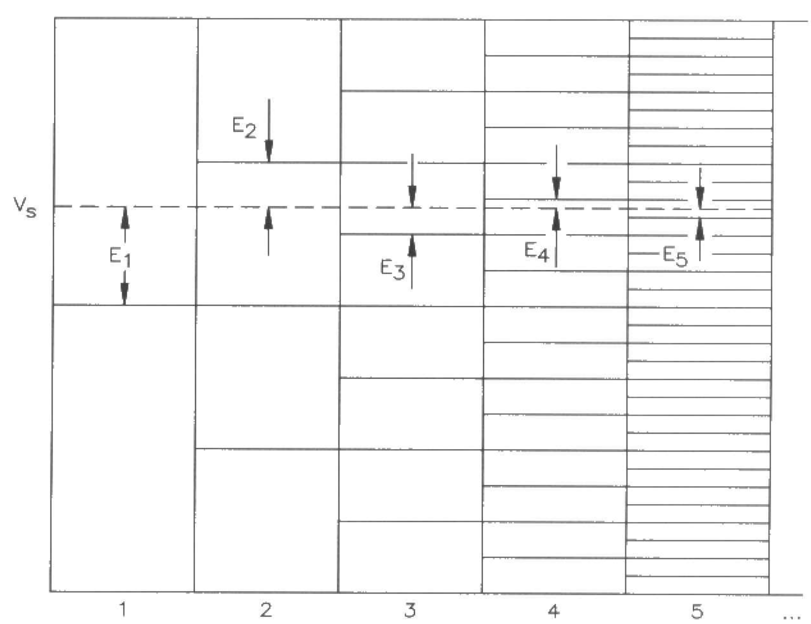


Figure 6. Because of rounding errors, sampling adds noise to the sampled sound. The more accurately that the samples are measured, the lower the average error, and the lower the resulting noise.

cannot keep up with the wheel, which completes more than one full rotation between frames. The result is that the wheel appears to move backwards, because the full rotation has been 'lost'. Figure 7 depicts aliasing distortion. To prevent this happening, samplers include filters at the signal input which roll-off the offending frequencies before they reach the analogue to digital conversion hardware, as Figure 8 shows. A similar filter is used at the other end of the process, to remove glitches from the sample-and-hold, and to 'join-the-dots' of the sampled measurements, to make sure that the original signal is recreated. Figure 9 illustrates this method.

Most samplers allow the user to set the sampling rate, either discretely, with a preset selection of sampling rates (such as 16kHz, 32kHz and 48kHz), or completely freely. Full bandwidth sampling gives the best results, but it also uses the most RAM, and there are applications (such as the sampling of vocal snatches, or sampling off a low-fidelity medium such as cassette tape) where the full range is not needed.

How is sampling used in practice? There are two main applications: the simulation of other instruments, and the creation of cut-and-paste musical collage effects. The application of sampling to real instrument simulation is obvious. A synthesizer can only provide an approximation to a real sound, while a sampler can accurately record and reproduce the original. To make the effect more realistic, real sounds are usually multi-sampled, as depicted in Figure 10. The sound of a piano varies greatly from one end of the keyboard to the other. It also varies depending on how hard a note is struck. Sampling a single note, and playing it across the full range of a piano, creates a very peculiar (and un-piano like) sound indeed.

To create an accurate piano simulation, a selection of different piano notes are sampled and then laid out in ranges across the keyboard. The effect is not totally convincing, because the tone quality of the notes can change rather obviously between regions where different samples are used. But for anything other than polished classical performances, this can create a very usable piano sound. See Figure 11. To make the simulation even more effective, sounds can be sampled at different levels. Each keyboard range may have three samples instead of one, recorded at low, medium and high levels. The sampler will switch, or perhaps

Type	Effective Resolution (bits)	SNR (dB)	Typical applications	Example machines
8-bit linear	256	48	Early professional sampling. Now only used for deliberately LO-FI music (e.g., house and rap), and for sampling speech.	Fairlight CMI, series I and II, Emulator I
12-bit linear	4,096	72	Middle-era professional sampling. Still used very occasionally by budget-conscious sampling artists.	Akai S900 and S950
12-bit exponential	4,096	72+	A brave attempt, used by a handful of professionals, that otherwise never really caught on.	Roland S-series
16-bit linear	65,536	96	Now the industry standard, and used for most work.	Akai S-1000, S-2000 and S-3000 series. PC soundcards

Table 1. A brief history of sampling technology.

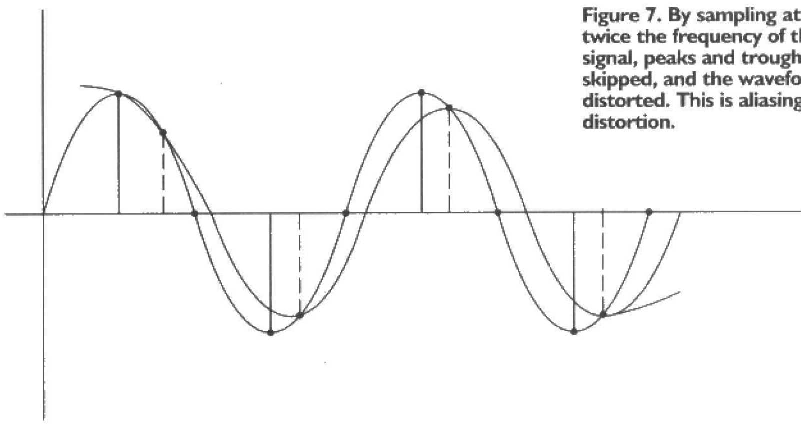
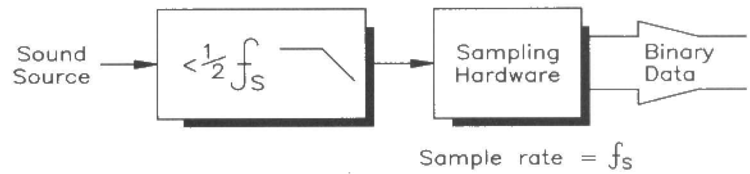


Figure 7. By sampling at less than twice the frequency of the input signal, peaks and troughs are skipped, and the waveform is distorted. This is aliasing distortion.

Figure 8. To prevent aliasing distortion, sounds are filtered before sampling. The filter cut-off frequency is less than half of the sampling rate.



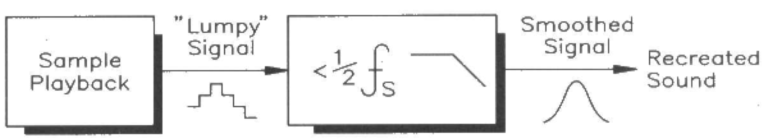
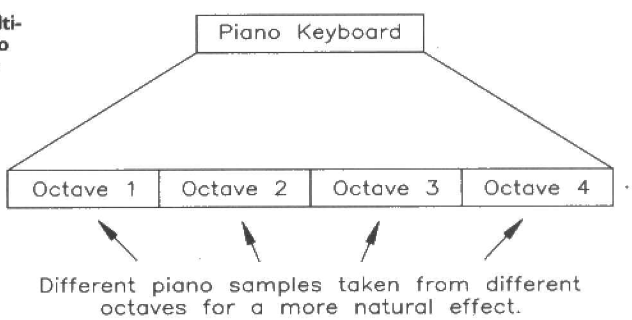


Figure 9. Similarly, on sample playback, a filter is used to reconstruct the original smooth waveform from the sampled steps. In recent designs, both these reconstruction filters and the input anti-aliasing filters are implemented digitally.

Figure 10. To create a more natural sound, sounds are multi-sampled across their range. To sound convincing, at least one sample of a piano note needs to be made at each octave.



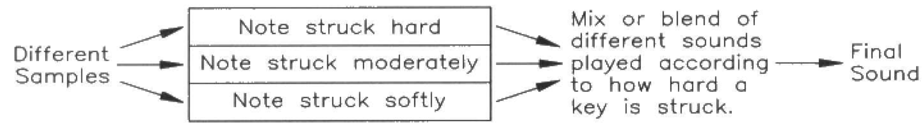


Figure 11. Sounds can also be multi-sampled according to how hard they are struck. A sampler can switch between these different sounds according to MIDI note velocity, to recreate the original effect.

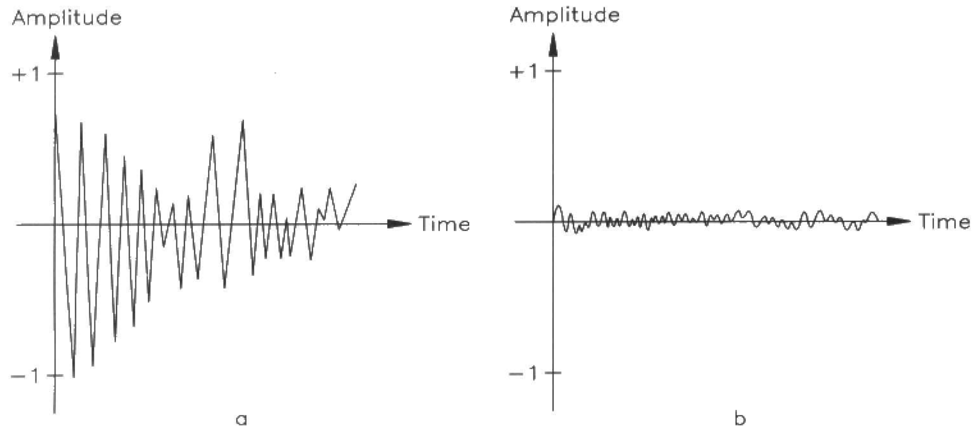


Figure 12. High amplitude sounds use the full range of measurements available. Low amplitude sounds do not, which results in a much lower effective sampling resolution.

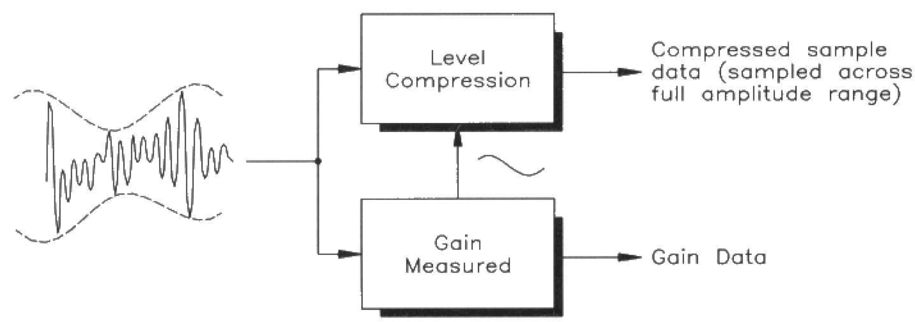


Figure 13. One way around this drawback is to sample waveform content and volume separately. Sometimes this information is recombined to give an equivalent linear sample measurement, arrived at by non-linear means.

fade between these, depending on how hard a note has been struck, a method illustrated by Figure 12.

Combining these two techniques can result in a very accurate and lifelike piano sound indeed, but the problem is one of memory; the more samples that are made, the more memory is needed. A fully comprehensive, multi-sampled piano, with samples made every octave, can easily take up 16M-bytes. So, most of the time, compromises are made between sound quality and RAM requirements. Of course, what applies to the piano can apply to any other instrument or instrument group. Film composers often use orchestral multi-samples, to create a full orchestral sound within the comfort of their studio. Although the sound does not have the vibrancy and articulation of the real thing, this technique is often used on low-budget productions, to create a convincing orchestra-like effect.

But, it is in the area of sound collage work that sampling has been most successful. Indeed, the sampler has shaped the music of the '90s like no other instrument. Because any sound can be sampled, it is trivial for a sampling artist to take a snatch of existing music (such as a drum part) and use that as the foundation of a new piece. Alternatively, sounds can be transposed up or down, and cut and pasted together in such a way that the original source sound is completely changed into something new and original. One of the most effective uses of the sampler in ambient music is simply to take

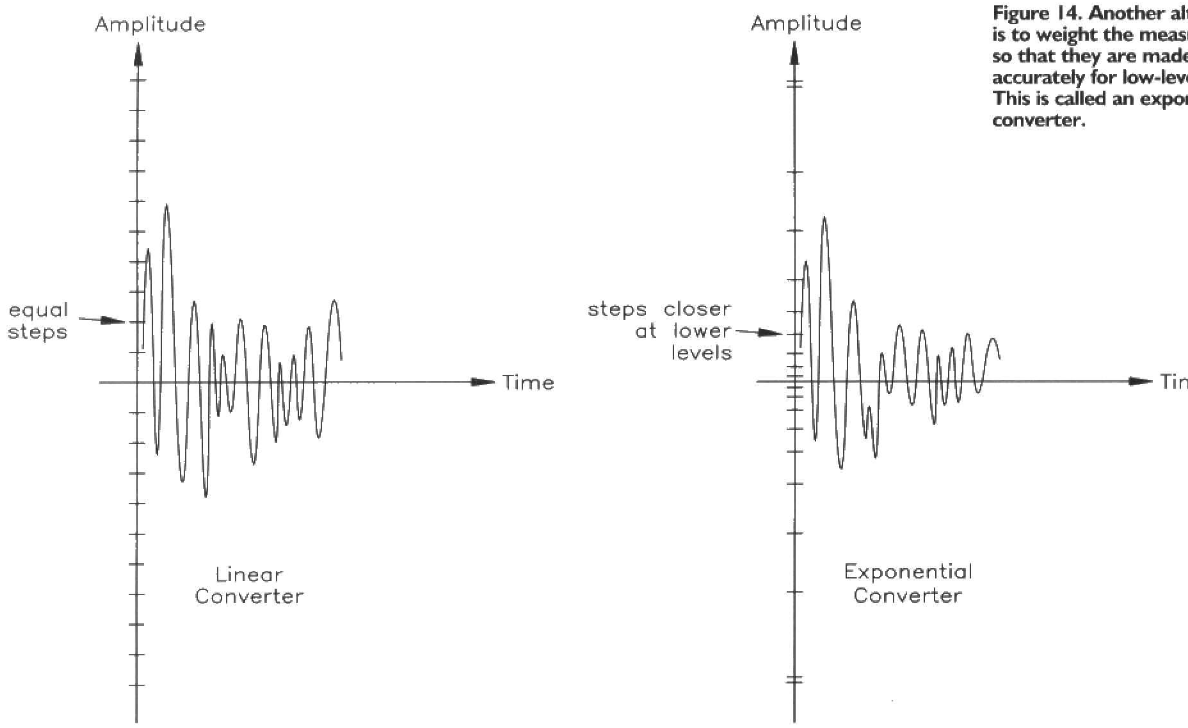


Figure 14. Another alternative is to weight the measurements so that they are made more accurately for low-level signals. This is called an exponential converter.

a few seconds of music and transpose down an octave or two. The results can be eerie, haunting and atmospheric, and are easily achievable by anyone with even the most basic of modern samplers.

Linear or Exponential?

Most sampling systems use linear components, whereby the full sampled range is divided up into equal steps. However, a few attempts have been made to use non-linear sampling schemes, which have both advantages and disadvantages.

One problem with linear sampling, is the way the system deals with low-level signals. Although a full-scale sine wave may approach the maximum theoretical signal-to-noise ratio, most music signals consist of quieter sections with occasional peaks. This means that the effective signal-to-noise ratio can be greatly reduced. Very low-level signals (such as the reverberation from a concert hall, or the finer sonic details created by an acoustic instrument) will be sampled with a relatively poor sampling resolution, as Figure 12 depicts. One way around this is to 'ride-the-gain' of the signal. Two measurements are made, one of volume, and one of the signal itself, which has been compressed to offer a more steady level, and thus make the best use of the converter's resolution, as shown in Figure 13.

Another approach is to vary the quantisation at different signal levels. In a linear system, each measurement step is constant. An exponential system measures low levels more accurately than high levels. The overall distortion level remains constant, but more low level detail is preserved – see Figure 14. Although both of these techniques have been tried, they run into problems. Most samples are edited after they have been created. They may be mixed together, or spliced, or joined by a gradual fade. The calculations required to do this are significantly more complicated if the sample data is not in a linear form.

As a result the industry has settled on 16-bit linear sampling as the standard. The results are good, if not quite perfect, the technology is affordable, and the sampled data can be easily edited and stored on a personal computer. Although in the professional field, higher sampling resolutions (such as 20-bit, and even 24-bit) are becoming available, the 16-bit standard is likely to be around for some time to come.

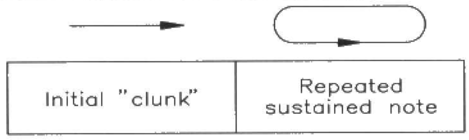


Figure 15. To save memory, a sound is often looped, so that some part of it plays repeatedly. Here, the initial characteristic 'clunk' of a piano note is played once, and then the more stable, sustained sound is looped, to create a more efficient, but still realistic, piano sample.

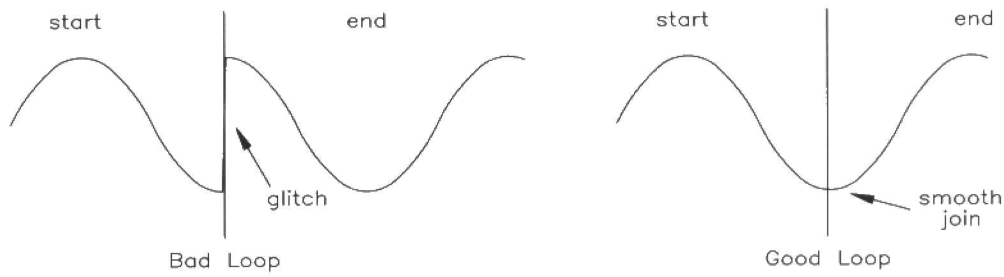


Figure 16. Loops can be fiddly. Ideally, the start and end points of the loop need to join smoothly, otherwise an annoying click will be heard when the level jumps.

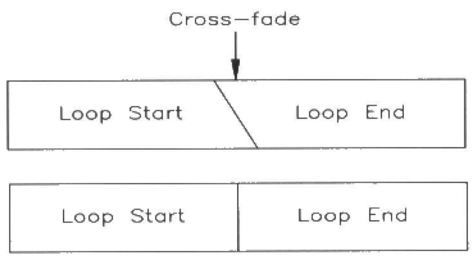


Figure 17. To get around this, samplers include 'crossfade' facilities, which blend the start and end sample data smoothly. This reduces the chances of a click, and makes the sample easier to loop where it works musically, and not just technically.

Memory Considerations

RAM may be cheaper now than it has ever been, but it is still a major consideration for the avid sampling artist. Professional samplers come with a minimum 2M-bytes of RAM, which can be expanded anywhere up to 64M-bytes on a top-end professional machine. Assuming a typical sampling rate of 32kHz (which will give a frequency response equivalent to an FM radio station), 2M-bytes gives 32 seconds of 16-bit mono sound. Because it can take an age to load 2M-bytes of sound data off a floppy disk, many professional samplers include an optional small computer systems interface (SCSI) hard disk interface. This can be used to speedily store and retrieve sounds for later use.

One feature used to make better use of sample memory is looping. Instead of playing a sample all the way through once, one or more sections of the sample can be repeated indefinitely, as Figure 15 shows. Additional fade effects can be programmed in, using the sampler's envelope generators or filter. This has the effect of enhancing the length of the sample, without taking up any more RAM.

Looping, however, can be problematic. For a perfect loop, the start and end points have to match exactly, otherwise an annoying click will appear, as depicted in Figure 16. Needless to say, naturally-occurring, perfect loop points are rare. Accordingly, sampler designers have produced a number of helpful features to combat this dilemma. At their simplest, these can scan the sample data, looking for possible loop points. A more complicated (and useful) option, is to crossfade sample information between the start and end points, as shown in Figure 17. This merges the signal at these two points, and can (in theory) smooth out any discontinuities, and create a clean and clear-sounding loop. E

PLUG INTO PCMCIA – *Continued from page 67.*

A mere four years after the first standard was introduced, there are a huge variety of cards and machines to run them on. However, there have been problems. Some users have reported that certain cards do not work in their machines, or that they are unable to 'plug and play'. In many cases, portable computer manufacturers are 'forgetting' to include Card Services and Socket Services programs on their system disks, which would account for most of the problems. There is absolutely no excuse for not including Socket Services, which is pretty much machine-specific, and without which, the slot is useless. The PCMCIA standards are voluminous documents – Release 2.1 occupies 742 A4 pages – and every detail has to be strictly observed to guarantee absolute compliance to the standard. Hardly surprisingly, not all products comply completely, which is a blow to the 'plug and play' concept. If you are considering purchasing PCMCIA peripherals to use with your notebook PC, it is recommended that you take your machine to the dealer and try them out before parting with your money. It must be said that it is still early days for PCMCIA, and that these infrequent incompatibility and negligence issues will be addressed as time goes by. Whatever happens, its future is rosy. Perhaps, one day, the number of PCMCIA peripherals out there will begin to approach the number of credit cards in use! E

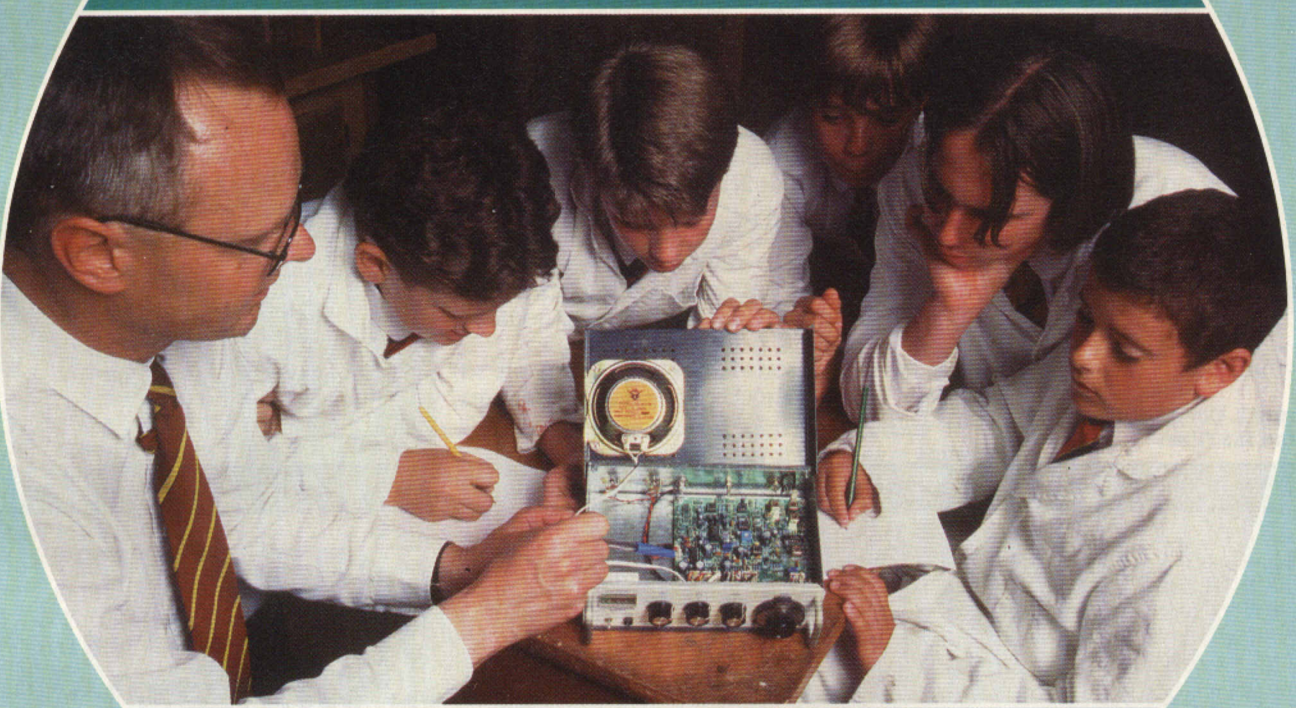
Contacts

PCMCIA, 1030 East Duane Avenue, Suite G, Sunnyvale, California 94086, USA.
Tel: (0101) 408 720 0107 Fax: (0101) 408 720 9416.

KIT AVAILABLE
(90057)
Price
£4.99

1
PROJECT RATING

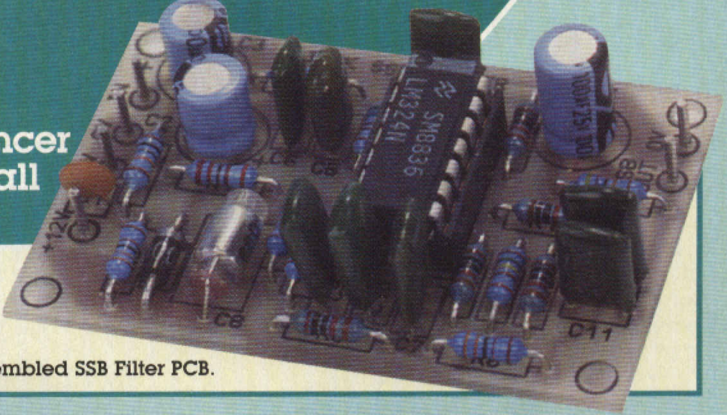
SSB FILTER



Design by Ben Spencer
Technical support by Nigel Skeels
Text by Ben Spencer and Robin Hall

FEATURES

* Ideal novice project
* 8-pole Chebyshev filter
* Low power consumption
* Reverse polarity protection



Assembled SSB Filter PCB.

Specification

DC power supply voltage:	11 to 15V DC
Filter type:	Active 8-pole Chebyshev
Passband ripple:	±0·5dB maximum
Bandwidth:	–3dB points approx 250Hz & 3200Hz
	–6dB points approx 240Hz & 3400Hz
Input impedance:	24kΩ
Overall gain:	0dB

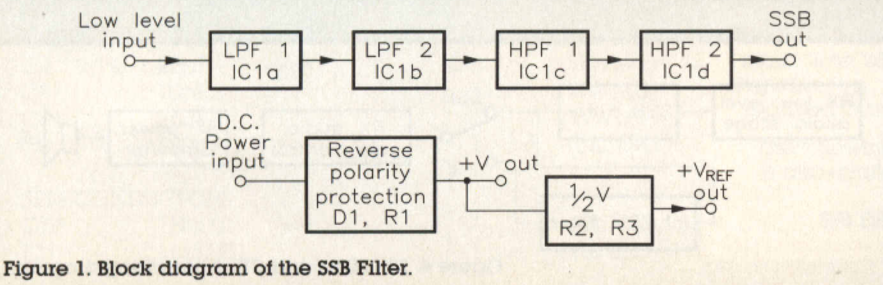


Figure 1. Block diagram of the SSB Filter.

Although many homebrew or kit receivers are generally adequate for SSB reception under normal conditions, this is not always so, especially during contest conditions or openings on the bands. It becomes increasingly difficult to pick out the DX as the number of stations tend to seemingly overlap. One method to overcome this is to have an SSB filter fitted into the receiver, this is similar to the CW filter except that it is used over a limited bandwidth rather than a single frequency.

Circuit Description

Refer to the block diagram in Figure 1 and to the circuit diagram in Figure 2. Reverse polarity protection is provided by R1 and D1. Capacitors C1 and C2 provide supply decoupling.

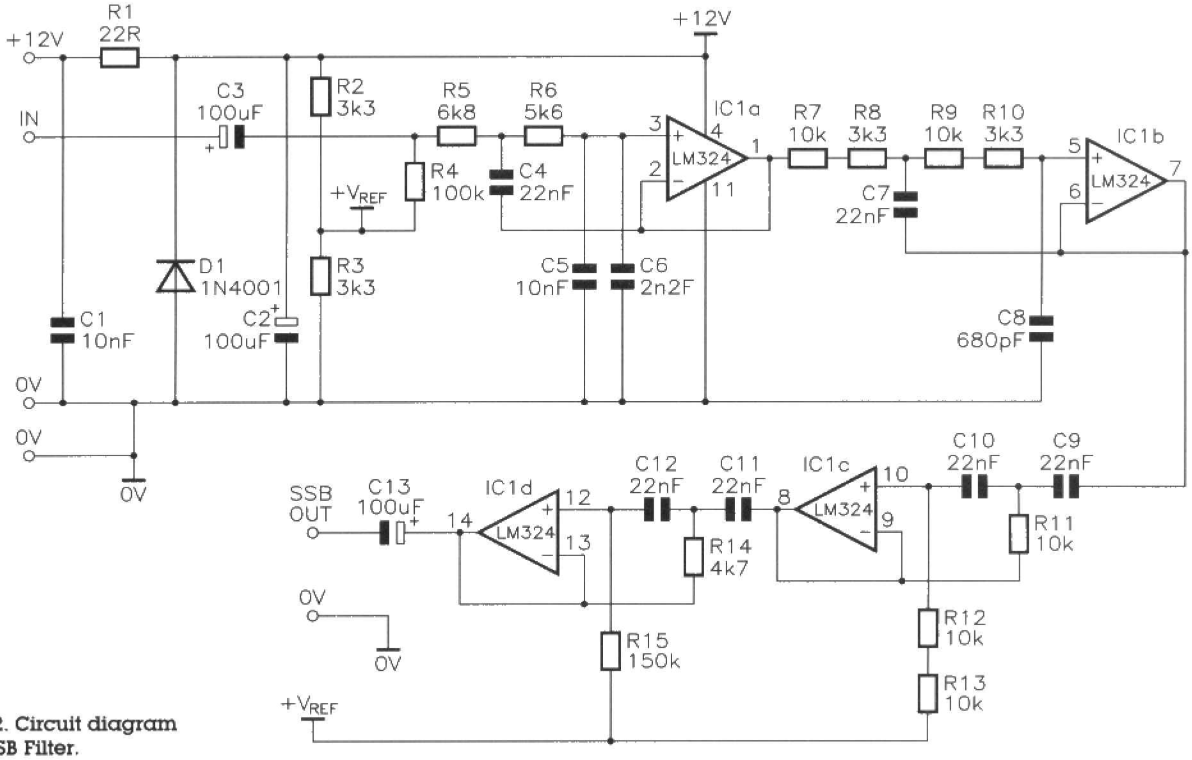


Figure 2. Circuit diagram of the SSB Filter.

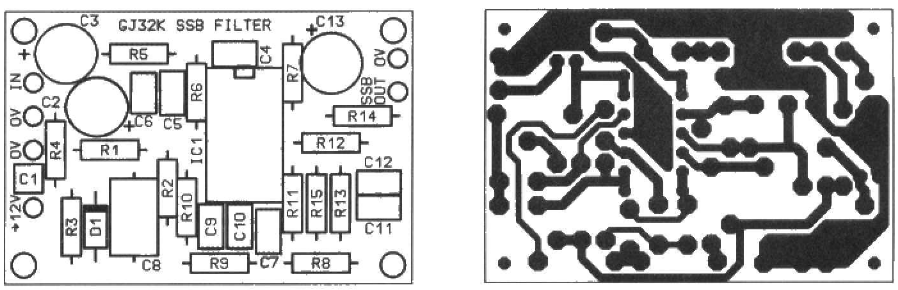


Figure 3. SSB Filter legend and track.

As the op amps operate from a single supply rail, a half rail reference V_{REF} is provided by R2 and R3. To obtain the correct values for the filters, some components are arranged in parallel or series. In total four Sallen and Key filters in ±0·5dB ripple Chebyschev configuration are used providing a total of 8-poles. There are two cascaded low-pass filters (LPF) followed by two cascaded high-pass filters (HPF).

The AF input signal is coupled by C3 and passes to the first LPF formed by R5, R6, & C4, C5, C6 together with IC1a, the second LPF is formed by R7, R8, R9, R10, C7, C8 & IC1b.

The first HPF is formed by C9,C10,R11,R12,R13 & IC1c. The second HPF is formed by C11,C12, R14,R15 & IC1d. The filtered output is coupled by C13.

Construction

Construction is fairly straightforward, refer to the Parts List and to Figure 3 for the PCB legend and track layout. Begin with the smallest components (i.e. PCB pins, resistors and capacitors) working up in size to the largest. If you are new to project construction, please refer also to the Constructors' Guide (XH79L) for hints and tips on soldering and assembly techniques.

Be careful to orientate correctly the polarised devices, i.e. electrolytic capacitors, diode and IC. The IC should be inserted last of all.

Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. When the PCB has been fully built up, clean all the flux off using a suitable solvent.

Fitting the SSB Filter

The board operates on 11 to 15V DC and in the majority of receivers this supply should not be a problem. The positive supply is connected to (+12V), and to ground (0V). The low level audio input is connected between (IN) and ground (0V). The audio output is taken from (SSB) and ground (0V).

There are generally two options in fitting the SSB Filter. One is to insert the SSB Filter in line between the receiver low level audio stage and the audio gain control. If this method is approached then the AF signal path, must be interrupted just before the AF power amplifiers gain (volume) control. The SSB Filter is inserted at this point. Figure 4 shows the wiring diagram of the SSB Filter in a typical receiver. The breaking of the AF path will depend upon your receiver. Some form of switching arrangement may be incorporated to enable the SSB Filter to be switched in or out as required in conjunction with the CW Filter. If the receiver is home brew or of kit origin then fitting this module is less likely to be a problem, but it is not

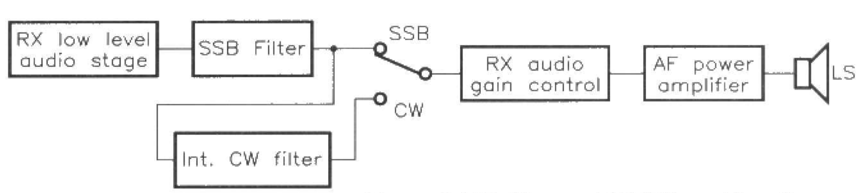


Figure 4. SSB Filter and CW Filter wiring diagram.

advisable to fit it into a professional receiver, especially if still under guarantee.

Another method is to have the SSB filter attached externally to the receiver audio output, and there are generally audio connections available. The audio output from the filter can then be fed via an audio amplifier, and then onto headphones or a loudspeaker.

Operation

Operating the SSB Filter is very easy. Switch on the receiver and find a suitable single sideband (SSB) transmission, preferably on an amateur radio band. There are conventions that generally indicate that amateur radio SSB transmissions are on lower side band on the lower permitted bands 1·800 to 2·00MHz (160m), 3·5 to 3·8MHz (80m) and 7·0MHz to 7·1MHz (40m), and USB on the higher amateur bands above 10MHz. Commercial SSB transmissions are generally upper side band (USB), but there are exceptions to the rule, so be prepared to tune around slightly, if the signal does not resolve.

If the bands are busy, then more than one signal should be heard almost on the same frequency. Depending on how the SSB Filter has been wired into the receiver, switch in the filter and slightly adjust the tuning of the receiver. The SSB signal should be resolved when the audio signals sound normal. On some commercial transmissions there is a pilot carrier and this is useful to assist in obtaining the correct tuning and pitch of the voice, this for some reason is especially difficult to get the right pitch on female voices.

The SSB Filter is tuned to a bandwidth 250Hz to 3200Hz which is acceptable in communications. With practice, tuning SSB signals will become second nature. If the SSB filter is to be used in conjunction with the CW filter then a narrower passband will be obtained when switching in the CW filter, but this will only be usable on CW signals.

First Symbol – Type of modulation of the main carrier.
A–Double Sideband, H–Single Sideband, full carrier, R–Single sideband, reduced or variable level carrier, J–Single sideband, suppressed carrier.

Second Symbol – Nature of signal(s) modulating the main carrier.
2–A single channel containing quantised or digital information with the use of a modulating subcarrier.
3–A single channel containing analogue information.

Third Symbol – Type of information to be transmitted.
A–Telegraphy – for aural reception.
B–Telegraphy – for automatic reception.
C–Facsimile.
D–Data transmissions, telemetry.
E–Telephony.

So a voice single sideband, suppressed carrier (SSB) transmission would be designated J3E, an amplitude modulation (AM) transmission would be designated A3E, and hand sent on/off keying of the carrier, (Morse or CW) designated A1A.

It is worth noting that these designations are commonly used in radio frequency guides and on the air on commercial bands, rather than the more common ones such as SSB, AM and CW.

For the Radio Amateur Licence Holder (A) or (B), the Terms, Provisions and Limitations are given in booklet BR68.

Table 1. A selection of the relevant classes of emissions.

General Information

The International Telecommunications Union (ITU) is responsible for terms and provisions governing all aspects of communications, with signatory Governments responsible for upholding these Telecommunication Conventions as inshrined in laws passed in those countries. Codes for classes of emission under the Telecommunication Convention are designated by groups of figures, these are tighter in meaning than the ordinary terms such as CW, SSB, AM, etc., see Table 1.

The assembled PCB.

SSB FILTER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	22Ω	1	(M22R)
R2,3,8,10	3k3	4	(M3K3)
R4	100k	1	(M100K)
R5	6k8	1	(M6K8)
R6	5k6	1	(M5K6)
R7,9,11-13	10k	5	(M10K)
R14	4k7	1	(M4K7)
R15	150k	1	(M150K)

CAPACITORS

C1	10nF 50V	1	(BX00A)
C2,3,13	100μF 16V	3	(RA55K)
C4,7,9-12	22nF	6	(WW19V)
C5	10nF	1	(WW18U)
C6	2n2F	1	(WW16S)
C8	680pF	1	(BX34M)

SEMICONDUCTORS

D1	1N4001	1	(QL73Q)
IC1	LM324N	1	(UF26D)

MISCELLANEOUS

PCB Pins	1 Pkt	(FL24B)
14-pin DIL Socket	1	(BL18U)
PCB	1	(90058)
Instruction Leaflet	1	(XV79L)
Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As 90057 (SSB Filter) Price £4.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1995 Maplin Catalogue.

SSB Filter PCB **Order As 90058 Price £1.99**

@Internet

Many (probably most) of our readers who use the Internet, will do so via a dial-up connection to an Internet providers point of presence (POP). In the majority of these cases, it will be over a conventional telephone line, using a modem to connect the line to their computers. Several, though by no means all, will be using the latest generation of modems, rated at 28,800bps.

While sounding quite fast (well, a lot faster than the 4,800bps modems which were commonplace just a year ago) these modems are still often the weakest link in the network chain, from the computers you access around the world to the computer you type their universal resource locators (URLs) into on your desktop. For many purposes, modems of this calibre are great. If you just want to hop between sites without downloading too many graphical images, then they do the job more than nicely, and are actually quite nippy if the Internet itself isn't too busy with traffic. But, things are changing onboard the Internet. Page designers, while aware that many people's access speed is limited, don't want their pages to be just textual (and hence, pretty boring). Visual elegance is becoming commonplace, but with that comes the use of more and more graphical images.

Commercial ventures (product catalogues, sales brochures, online magazines, even just ambitious individuals) want to add images to make their pages interesting and appealing. On top of this, we are but a stepping stone away from video hyperlinking, with its attendant order of greater bandwidth requirements. An integrated services digital network (ISDN) connection, however, could resolve all these speed problems and open up the world of video on the Internet to the dial-up user. As yet, the hardware to do this (the digital equivalent of the modem) is quite expensive. An ISDN card for a PC figures at just under £1,000 or so. On the other hand, you have to weigh up the reduced call costs. Call charges per minute of the digital connection are the same as conventional analogue telephone call charges, so the increased speed on communications (potentially between 10 to 20 times) could mean that you drastically reduce your overall costs.

This all depends on your Internet provider's equipment at your local point of presence, though. If there's no ISDN interface, you can forget it. And if the ISDN interface isn't up to the same speed as yours (as first occurred when 28,800bps modems came online and POPs still only had 14,400bps modems), and then the whole lot defaults to the lowest common speed, which is probably going to be 19,200bps anyway – hardly worth the time or investment. But, given that all things are OK, and that points of presence have sufficient numbers of these ISDN interfaces to pick up the incoming lines, then the world's yer lobster. Which is just like déjà vu – all over again.

Publishing Web Pages on the Internet

A Web page is simply a text file containing information in a simplistic text based language, called HTML (HyperText Markup Language), which tells the browser how it should be displayed. Individuals wanting to create their own Web pages have, until recently, had to programme in HTML. To create a Web document, the text image is compiled together with any graphical input before HTML codes are inserted, to enable links, buttons or moving images.

But, there are easier ways. Users of WordPerfect 6.1 for Windows can now download a piece of software from Novell's Web site, which enables HTML documents to be compiled within WordPerfect. In essence, the Novell Internet publisher is a printer driver which patches into an existing copy of WordPerfect once downloaded and run. Documents are created in the usual manner, with codes inserted to add functionality.

Once created, the document is exported as a HTML file, which can be sent to Internet Providers for publication on the Web, unless of course, you own and manage your own Web site. Internet Provider's such as Delphi, Demon and Pipex, are able to provide a subscriber with a unique Web site for a fixed fee each month. Novell's Internet Publisher comes with Netscape 1.0, so that Web designers can check out their own designs prior to virtual publication. Novell's Web site is at: **http://www.novell.com/**

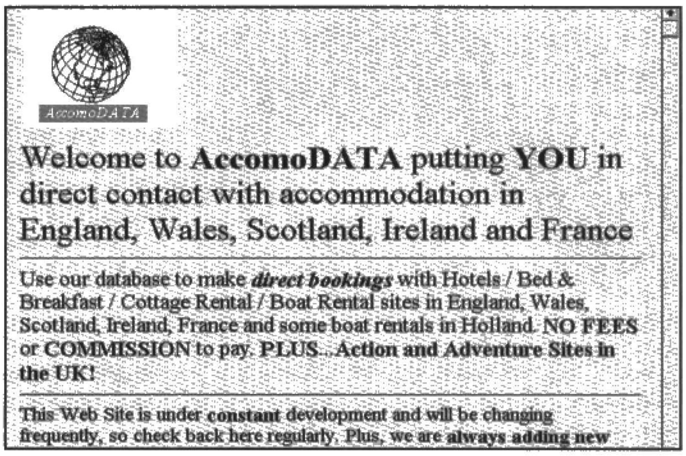
Internet Addiction

A Plymouth University psycologist is investigating Internet addiction. Dr. Mark Griffiths, an addition psychologist, claims the obsession is similar to gambling. Internet users can spend hours cruising the World Wide Web, downloading software, and participating in Internet Relay Chat. Griffiths plans to put a questionnaire on the Internet from October. The results of his work are expected in May next year.

Contact: (01752) 600600.

Summer Holidays

If you haven't booked a holiday yet, and are wondering were to go, check out the AccommoDATA site at: **http://www.cityscape.co.uk/users/eb19/**. Here, you'll find details and availability of cottages, hotels, boats and castles throughout the UK and France. Unfortunately, the WWW site cannot handle bookings. These are handled through more conventional channels.



Computer Porn

There has been a lot in the media recently about the dangers of computer porn, which is (according to which medium and which particular journalist) apparently rife on the Internet. However, while there *is* a danger of improper images being broadcast to an unsuitable audience (and we're talking children here), this is no more a threat than, say, the same images being handed about the playground on floppy disk, or come to that, passed between our children in a magazine format.

While we shouldn't ignore the possibility of incorrectly influencing our kids, we need to be careful that we don't spend too much time denouncing the Internet, at the same time side-stepping other more important issues. There is always the off switch, after all.

Penny a Minute for BT Local Calls

BT has introduced a new low weekend rate for local calls, which means it now costs only 1p/min to get online in your local area. Outside your local area, the cost is 3·3p/min on weekends anywhere in the country. Weekend rates apply from midnight Friday until midnight Sunday. Calls in the evening from Monday to Friday are charged per minute at 1·7p local, 4p regional and 5·8p national. This is all good news for online subscribers. But when you consider that BT reported a first quarter profit of £874 million before taxation, the company could afford to follow cable operators by offering free local calls.

Contact: British Telecom, Tel: (0800) 800891.

Demon Expands Points of Presence

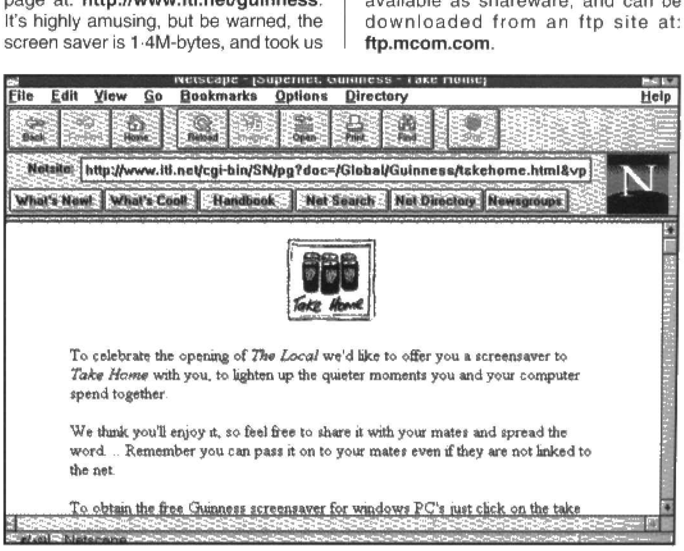
Demon Internet intends to broaden its Points of Presence (POPs) to match up with its main rival, CompuServe. The new program will involve phasing out its present series of local POPs – where Demon equipment is located in each region. These will be replaced with a larger network of virtual POPs, whereby calls are forwarded direct to Demon's Finchley headquarters. The POP expansion also includes access into Scotland using Scottish Telecom, the Scottish equivalent of energy generating company, Energis. Demon's proposals mean that 78% of the mainland UK will be able to locally dial a Demon Internet POP.

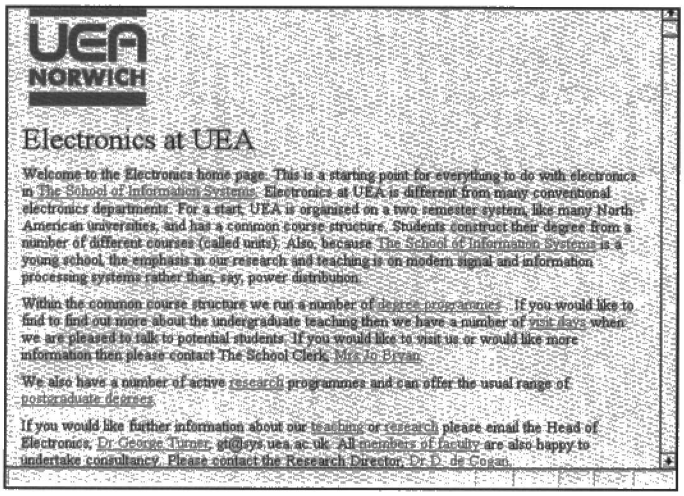
Contact: Demon Internet, Tel: (0181) 371 1000.

Screen Saver – Mine's a Guinness

A classic piece of marketing here from Guinness. You've bought the drink, seen the television advertisement, now get the screen saver! Guinness fans can download a screen saver version of the television advertisement – complete with silly tune – from the Guinness home page at: **http://www.itl.net/guinness**. It's highly amusing, but be warned, the screen saver is 1·4M-bytes, and took us around 20 minutes to retrieve with a 14·4K-baud modem.

You'll also need a Netscape WWW browser, as the Guinness WWW page is animation based. Netscape is currently the only browser able to handle moving images. Fear not, this too is available as shareware, and can be downloaded from an ftp site at: **ftp.mcom.com**.





Surfing Technology

Continuing our trip around the sites of electronic's companies, first stop this month is Digital Electronics, at: **http://www.digital.com/**. Here, you'll find the usual technical information, together with a couple of interesting items.

The Digital site has reading rooms where you can go and browse through technical literature and manuals. In addition, there's a powerful search engine if you want to check out a particular subject. What's particularly neat about this site, is that you're offered the option of where or not you wish to download graphics.

Back to UK, the University of East Anglia, Department of Electronics Home Page can be found at: **http://www.sys.uea.ac.uk/ese**. Here, you'll find details of the universities' degree courses, and lecturers available for contact via e-mail. In true student style, the page also contacts some links to some wacky, and it has to be said, some not-so-wacky sites.

From the University of East Anglia, I jumped to the IEEE Web site. Wacky or not-so-wacky, decide for yourself at: **http://www.ieee.org/**. This is the US version of the IEE, so you'll find plenty of academic papers, and research material. If you're undertaking research in any area of electronics, this may be a good place to start.

BT Increases Internet Presence

BT has so far been fairly quiet on the Internet front. However, the company plans an expansion of its services. From August, it will be cheaper for BT business customers located in Scotland, England and Northern Ireland to connect to the Internet, following the announcement of the roll-out of three new Points of Presence (POPs) in Edinburgh, Belfast and Birmingham. The announcement marks the start of BT's push to expand Internet access services globally and increases the number of BTnet POPs in the UK, with sites currently in London and Manchester.

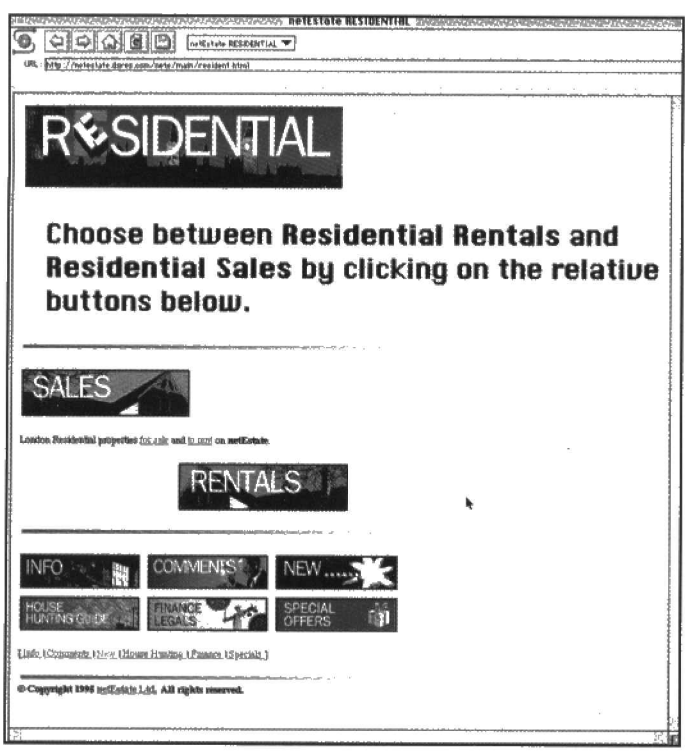
As a measure of BT's commitment to customers requiring local access, POPs are planned around all major UK conurbations. Comprehensive Internet access offered through BTnet includes the availability of all established Internet tools – e-mail, Telnet, ftp, and the World Wide Web, together with access to Usenet News.

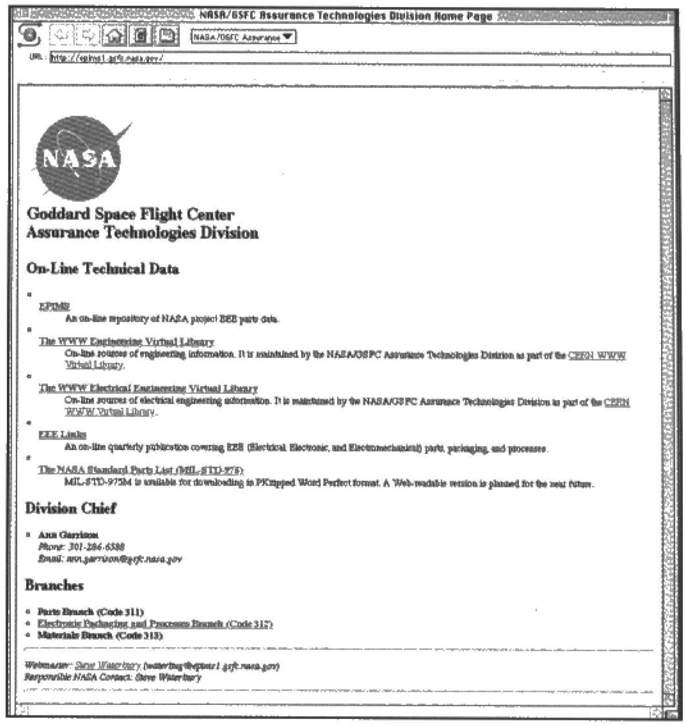
Contact: BT, Tel: (0181) 569 9768.

Site Survey – the month's destinations

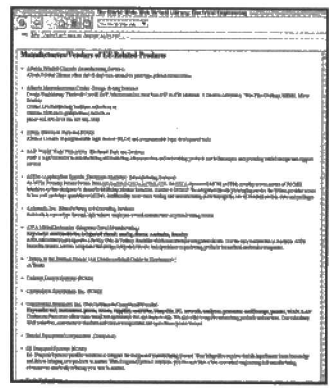
An interesting bundle of sites around this month. Firstly, if you're moving home in London, try the UK's first Internet property service, *netEstate*. This is a collection of estate agents who've got together to advertise over the Internet at the URL: **http://netestate.dsres.com**

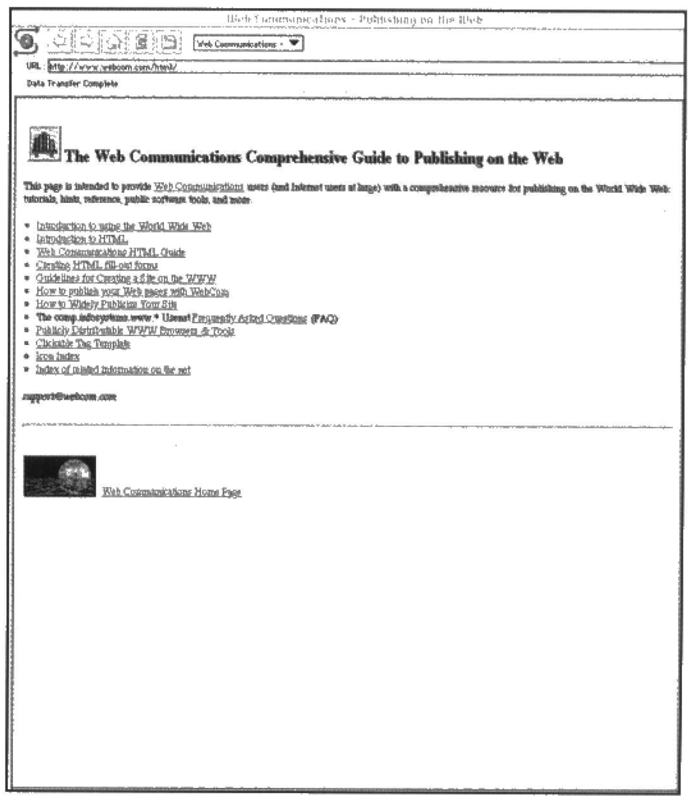
It makes sense, of course, for users to access the service – they don't have to trudge around all the estate agents to register with them first, and details can be transmitted much faster than by post. Also, by being able to specify their criteria online, searches of available properties are more accurate and much faster too.





On the electronics front, try NASA's Goddard Space Flight Center's Assurance Technologies Division home page at: **http://epims1.gsfc.nasa.gov/** – where you'll pick up several interesting links. Specifically, at the URL: **http://epims1.gsfc.nasa.gov/engineering/ee.html** is a pretty comprehensive listing of Internet locations for manufacturers and vendors of electronic engineering-related products.





Finally, if you are considering publishing on the Internet yourself, you could do worse than take a look at Web Communications' guide to doing it. The URL is: **http://www.webcom.com/ html/**

It is a veritable minefield of explosive information, and hidden under the hyperlinks will be just about every software tool you will need, as well as considerable information in the form of advice as to setting about generating your own World Wide Web home page. If you get up there, drop us an e-postcard to let us know! **site_sur@maplin.demon.co.uk**